A

GENERAL SYSTEM

OF

CHEMICAL KNOWLEDGE,

&c. &c.

A

GENERAL SYSTEM

OF

CHEMICAL KNOWLEDGE;

AND ITS

APPLICATION

TO THE

PHENOMENA OF NATURE AND ART.

BY A. F. FOURCROY,

Of the National Institute of France, Counsellor of State, Professor of Chemistry at various Public Establishments, Member of many Academies, &c.

IN ELEVEN VOLUMES.

TOGETHER WITH A SET OF SYNOPTIC TABLES IN LARGE FOLIO.

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BY WILLIAM NICHOLSON.

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OF

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EIGHTH SECTION.

Of the Animal Subſtances.

FIRST ORDER OF FACTS.

Generalities reſpecting the Structure and the Compoſition of the Animal Subſtances.

ARTICLE I.

Of the Structure of Animals.

1. AS I have conſtantly proceeded in the examination of the chemical properties of natural bodies from the moſt ſimple to the more compounded, it is neceſſary that I ſhould place the animal matters after the vegetable, becauſe they are of a more complicated order of compoſition. Accordingly their analyſis being more difficult, is leſs advanced, and the reſults that are drawn from them are leſs numerous and leſs certain.

Whatever differences are obferved between thefe two claffes of objects, there exifts, however, infinitely more relations between the animal and the vegetable fubftances than between the latter and the foffil matters that have been treated of before them; on account of thefe analogies the animal matters fhall here be confidered in the fame manner as the vegetable, though with fewer details, as their hiftory is lefs complete. I fhall comprehend all that appertains to their chemical properties under four orders of facts.

The firft fhall prefent what is requifite to be known concerning their ftructure and their general properties both as living bodies and as particular compounds, in order to render the expofition of their chemical properties fufficiently intelligible.

In the fecond order of facts I fhall exhibit the whole of their general chemical characters or the feries of their diftinctive properties difcovered by chemical inftruments.

The third order of facts fhall be devoted to the hiftory of the chemical properties of each particular animal matter.

Laftly, I fhall refer to the fourth order of facts which will terminate this fection, the applications of the chemical properties, both general and particular to the exercife of their functions, and to the bafes of phyfiology or

1 phyfics.

2. The

2. The firſt fact, which, as one of the moſt remarkable, ſtrikes in the moſt forcible manner the mind of every obſerver who compares the animals with the other natural bodies, is their exiſtence as ſubordinate to that of the vegetables. There is no one who does not conceive that without the plants no animals could exiſt, and that it is from them that they derive the nouriſhment which the mineral ſubſtances cannot afford them. Thus the vegetables, conſidered with reſpect to the rank which they occupy in the ſcale of beings, and to the relations which exiſt between them and the other productions of Nature, are placed in the middle between the foſſils and the animals. They borrow elements from the firſt, they combine them three and three by the power of vegetation; they prepare by the aid of this combination the alimentary matter for animals, they draw from the boſom of the earth ſubſtances which they bring to its ſurface, and which they aſſimilate in ſuch a manner as to render them proper for the ſupport of animal life: they can exiſt without the animals, but theſe cannot exiſt without them, and if they are not poſterior to them in their formation, they can only be their contemporaries.

3. It follows from this conſideration, that as the true problem of the nature of the vegetable ſubſtances compared with the mineral matters conſiſts in the formation of the former at the expenſe of the latter by the vegetative

power, that of the knowledge of animal ſubſtances compared with the vegetable muſt be comprehended in the inveſtigation of the converſion of the latter into the former. An animal of a given weight grows in a proportion alſo given, and in all its organs at the ſame time. The augmentation of bulk which it experiences can proceed only from the vegetable matter which it adds to its original weight. This ſingle fact well aſcertained proves inconteſtibly that the vegetable ſubſtances is converted into its own body, and becomes animal ſubſtance by a power innate in the body of this animal, a power which is termed *animalization*; and it ſhows at the ſame time that it is by diſcovering the laws, the phenomena, and the cauſes of this converſion, that we ſhall be able to acquire a knowledge of the nature of the materials which compoſe its body.

4. In order to acquire this knowledge, ſo very difficult to be obtained, and with reſpect to which we have hitherto only a few data, it is ſufficiently evident that it is indiſpenſably neceſſary we ſhould firſt know how the animals are conſtituted, or organized, eſpecially in compariſon with the vegetables, and this is what I here term their ſtructure. Rapid and general notions upon this ſubject will be ſufficient for our inquiries. Naturaliſts define animals as living organized beings, which change their ſituation, move themſelves, tranſport themſeves through ſpace, and are endowed with ſenſibility:

bility: they diſtinguiſh them ſufficiently from vegetables by the two latter properties; but this very looſe diſtinction does not fulfil the purpoſe that is to be attained. A number of other ſtill more ſtriking characters alſo diſtinguiſh animals from the vegetables; the external and internal forms differ much in theſe two claſſes of organized bodies. A ſlight ſketch of theſe characters muſt precede and illuſtrate the ſtudy of their chemical properties, as has been done with reſpect to the vegetables.

5. The body of animals reſembles that of vegetables only in a very few ſpecies. We find it divided into different regions or parts of a very different ſtructure, eſpecially in the beſt organized and moſt perfect animals. Of theſe, are particularly diſtinguiſhed the head, the trunk, and the extremities.

The firſt, including in the cranium the important organ of the brain, and the origin of the nerves, bearing outwardly the principal organs of the ſenſes, eſtabliſhes a direct communication and re-action with all the external objects by the eyes, the ears, and the noſtrils. The cavity of the mouth, which is placed in it, conducts to the organs of digeſtion and of reſpiration, and begins each of theſe functions.

The trunk compoſed of vertebræ ſupports a firſt oſſeous muſcular and membranous cavity, in which are lodged the heart and the large veſſels, the lungs, and the trachea; another

cavity

cavity provided only with muſcles and membranes in front, in which are diſpoſed under the diaphragm, which ſeparates it from the thorax, the viſcera of digeſtion, the ſtomach, the inteſtines, the pancreas, the ſpleen, and the liver, the internal organs of generation diſtributed differently in two individuals which form the ſexes in the greater number of animals, and alſo thoſe which ſecrete the urine.

The limbs or extremities, the one ſuperior or anterior, the other inferior or poſterior, formed of bones in their centre, of muſcles which cover and move them one upon the other like levers, terminated at their extremity the moſt remote from the trunk by diviſions more or leſs regular, ſerve the animals for ſeizing or repelling bodies, for removing them from, or bringing them nearer to them, and for bringing them into the medium which they inhabit.

6. Theſe three grand parts of the body of animals, the head, the trunk, and the extremities though very different in their uſes and apparent ſtructure, are, however, formed of fibres and laminæ which conſtitute textures or kinds of organs which are found throughout. Theſe organs, the firſt foundations of the animal body, are the bones, the blood, and lymphatic veſſels, the glands and the nerves.

The bones are the ſolid parts which determine the form of the body to which they give extent and ſolidity. They are connected with each other by ſolid membranes which are termed *ligaments;* their articular ſurfaces are covered with

with a white layer, leſs hard than themſelves, compreſſible and poliſhed, called *cartilage*, and moiſtened in their articulations with an unctuous liquid called *ſynovia*.

Over the bones are applied bundles of fibres, united into larger bundles, deſtined to cauſe the bones to roll one upon the other, and which are called *muſcles;* they have at their extremities white cords, which effect their attachment or inſertion into the bones; and are termed *tendons;* they are outwardly ſurrounded, and held together by hard elaſtic membranes, with brilliant fibres, which are called *aponeuroſes*. The muſcles are the organs of motion, and give the external form, the toroſity, the roundneſs, the projections, and the depreſſions of the ſurface.

Tubes or ſtrong membranous veſſels, proceeding from the cavities of the upper part of the heart, ramified and extended from thence throughout the whole body, conveying the blood which dilates them, and cauſes them to beat, and theſe are known by the name of *arteries*. At their extreme terminations they open into other tubes or veſſels, which are leſs dilated, leſs elaſtic, and leſs reſiſting, which take up the blood, and carry it from the ramifications to the branches, and to the trunks in the cavities of the baſe in the heart; theſe are the *veins*. Theſe two orders of canals form together the whole of the blood veſſels.

Under

Under the ſkin and between the muſcles, an
other order of veſſels, thin, tranſparent, tor
tuous, contracted in different places by interio
folds, filled with a white and tranſparent liquid
abſorb and ſuck in this liquid from every part
unite and ſeparate innumerable times, and al
paſs into the abdomen, behind the inteſtine
and the ſtomach, whither they carry the liquid
which there flows into one, two, or three trunks
which aſcend into the thorax, and open into
vein ſituated near to the heart, where the liquid
called *lymph* is mixed with the venous blood
theſe veſſels are called abſorbents, or lympha-
tics; they are diſtinguiſhed into the ſuperficia
and the deep; they are very much varied in
their ſtructure, and innumerable in their maſs
The chyle, the product of digeſtion, is mixed
with the lymph which they contain in the ab-
domen, and is poured with it into the venous
blood near the heart. The order of abſorb-
ent veſſels, which immediately draw in the
chyle in the inteſtines, are particularly diſtin-
guiſhed by the name of *lacteal veſſels.*

In many regions of the body of animals we
find bundles of blood veſſels, contorted in all
directions, and having different forms, con-
nected and preſſed together by very fine mem-
branes, which are termed *cellular texture.*
[illegible] thus balled together, interlaced
[illegible] each other, and forming a kind
[illegible] ly united with one another, very
various

various in their volume, are terminated, befides the veins which receive the blood again from them, by canals more or lefs wide, by refervoirs more or lefs ample, which pour into different regions, particular fluids. Thefe circumfcribed collections of veffels are called *conglomerate* glands. In this clafs or rank, the brain, the lachrymal glands, which prepare the tears, the parotids, the maxillary, and the fublingual glands which fecrete the faliva, the thyroid, placed under the larynx, the ufe of which is not known, the glands of the mammæ, which prepare the milk, the pancreas, forming the pancreatic juice poured into the firft of the inteftines, the liver, in which the bile is prepared, which flows together with the preceding fluid, the kidneys in which the urine is fecreted, and the tefticles, the fource of the femen. The abforbent veffels united into fmaller intertextures, conftitute almoft every where, but efpecially along the large blood-veffels of the neck, of the thorax, and of the extremities, at the axillæ, &c. *conglobate* glans, fo called, becaufe they are frequently rounded into a kind of globules.

From the bafe of the cerebrum, the cerebellum, the medulla oblongata, and the fpinal marrow, organs placed in the cranium and the vertebral canal, proceed white cords, which pafs out through holes, or fiffures, and fpread themfelves, dividing into branches, into ramifications, and into filaments, more and more minute, into all the other parts with the arteries, the

the veins, and the abſorbent veſſels. They eſtabliſh a communication with the ſeat of the ſenſations and ideas, and ſerve to form or modify both, as well as to convey the cauſe of motion according to the impreſſions made upon the organs of the ſenſes.

All theſe textures are glued together, though diſtinct and eaſily ſeparable, by a ſeries of very fine, and very tranſparent, flat lamellæ, forming between themſelves a multitude of continuous and communicating cells, on which account the whole has been called the *cellular texture.* This texture retains all the parts in their reſpective places; it is looſe and ſuſceptible of diſtention: it is this which unites the muſcular fibres into faſciæ, the different veſſels into bundles. It ſupports ſuch a great quantity of abſorbent veſſels upon its lamellæ, that modern anatomiſts believe it to be intirely formed of them. As it is always lucidated with a gluey and mucilaginous liquor, it has alſo been called mucous texture. We may repreſent it as a ſponge of the ſame form as the animal body, and into the cavities of which all the organs are as it were ſtuffed. The fat is depoſited in its cells.

7. Beſides theſe firſt organic elements, or general textures, which extend throughout the whole body of animals, which enter into the formation of the different regions of this body, we muſt alſo diſtinguiſh; 1. An organ, named ſometimes *lungs,* ſometimes *bronchiæ,* ſometimes

times *trachéa*, and which is destined to establish a communication, an uninterrupted contact between the blood, or other different humours of animals and the air, or the aërated water which they inhale; 2. A system of organs continued between two orifices, frequently placed at the two opposite extremities of the body, which receives, divides, dissolves, digests the aliments, and which represents in general a canal alternately dilated and contracted, provided with instruments and liquids, destined for bruising or dissolving the alimentary substances, to which canal are attached conglomerate glands, which pour into it dissolvent juices, especially the liver and the pancreas; 3. A third system of organs destined to perpetuate the species by generation, partly concealed in the interior of the body, partly situated or projecting outwardly, divided frequently into two sexes, the union of which, urged by instinct, is necessary for the re-production of the individuals. The one of these systems appears to contain the individual ready formed, but void of life; this is the female organ, or the agent of the feminine sex; the other, or the male organ, furnishes an exciting vivifying liquid, which communicates motion and life to the germ; 4. A fourth system which terminates, envelops, and contains all the others under the form of *teguments*, which cover the body, and which is in immediate contact with the water, or the air in which the animals live.

8. Each of the claſſes of organs, of which I have ſpoken, conſtitutes a particular ſyſtem, having a ſtructure, characters, uſes, and nature, different from thoſe of the other ſyſtems, actuated by a motion, an appetite, a manner, a ſenſibility, an activity, an aſpect, we might even ſay a life, which is peculiar to it. Thus we have to diſtinguiſh in the anatomical contexture of animals, the oſſeous, or ſolid *ſupporting* ſyſtem, the muſcular *irritable* ſyſtem, the ſanguiferous *circulating* ſyſtem, the lymphatic *abſorbent* ſyſtem, the glandular *ſecreting* ſyſtem, the nervous *ſentient* ſyſtem, the cellular *communicating* and *connecting* ſyſtem, the pulmonary *heating*, *ſanguifying* ſyſtem, the alimentary, or digeſtive *aſſimilating* ſyſtem, the genital *perpetuating* ſyſtem, and the cutaneous *perſpiring* ſyſtem. Each of theſe ſyſtems is connected with the others, and it is from their agreement, their aſſociation, their concord, their ſimultaneous and proportional action, that the affection of the animal economy reſults. The more of theſe ſyſtems are united in animals the more perfect they are. Man, who has them all, and in a regular and juſt proportion, is greatly ſuperior to all the other animals. The diverſities of force and energy, varied in the different ſyſtems, and their action, conſtitute the different temperatures in the ſame ſpecies.

9. On the variation of relations of ſymmetry, of number, of proportion between theſe ſyſtems, are founded the differences which exiſt between the animals and the claſſifications which

which have been made amongst them; beginning with man, and descending through degrees of organic degradation, more or less perceptible, down to the insects, the worms, and the zoophytes, in which many of these systems are either wanting or defective, for the more the anatomy of the animals advances, the more we find that the differences between them consist rather in the little harmony between the systems of the organs which constitute them, than in the want or total absence of these systems, as was at first believed. Aristotle first perceived, and this beautiful result has since been confirmed by innumerable anatomical observations, that the differences of these internal systems in the body of animals, were in some degree indicated by great differences in their apparent organs, or in the external parts; that this striking disparity followed and announced, especially in the extremes, the difference of the most important systems, those of the stomach, of the organs of respiration, of the brain, and of the nerves. The skin, naked, or covered with hair, with wool, provided with feathers, covered with scales, with a shell, the extremities more or less dissimilar, long, short, defective, or more or less divided; the fingers, more or less numerous or divided; the spinal column terminated below by the anus, formed of a greater or less number of pieces or vertebræ, prolonged into a tail more or less long, the face vertical or oblique, more or less oblong; the jaws more or less prominent, and

and conſequently the noſtrils, the mouth, and the tongue, more or leſs elongated; the cranium more or leſs ſmall, the forehead more or leſs projecting, with or without oſſeous appendages or horns: the occipital foramen, placed more or leſs behind, and in a line more or leſs approaching to the horizontal or vertical; the jaws, deprived of teeth, or having only few, or only certain claſſes, or only one of their parts;—these are the moſt remarkable differences, and moſt important characters which have been employed for diſtinguiſhing and deſcribing the animals from their diviſion into claſſes, to the ſeparation of genera.

10. According to this varied ſtructure, beginning with the moſt ſtriking differences, taken from the heart, with two, or with one interior cavity, with red or with white blood, circulating either entirely or only in part through the pulmonary organ, from the ſtomach ſingle or multiplied, from the brain and the nerves more or leſs abundant, from the mode of generation, viviparous, or oviparous, and deſcending ſucceſſively to the conſiderations of the body, provided with extremities, four, or only two in number, or deſtitute of theſe extremities, of the varied form of theſe parts, and of their diviſion, of the number, of the ſituation, of the relation, of the teeth, of the or- of maſtication in general, of the ſkin, naked, with hairs, with prickles, with ſcales, —All the animals, after man, the chief and primitive

primitive type of organized beings, have been diftinguifhed into eight claffes, namely the mammalia, the birds, the reptiles, the fifhes, the teftacea, the infects, the worms, and the zoophytes. The latter, the moft degraded in their ftructure and their functions, fixed to the foil upon which they have been produced, reduced almoft to the condition of the vegetables, to which they approach, and with which they have long been confounded, form the laft degree in the fcale of animals. Without entering upon this divifion and this claffification, into details foreign to my object, I fhall content myfelf with obferving, that all the beings comprehended in thefe ten claffes, at the head of which man ought to be placed in a particular and diftinct rank; though he has the moft ftriking analogies of ftructure and of orginization with the mammalia, refemble each other in the characters of animality, locomobility, the communications inceffantly kept up with the medium which they inhabit, the prompt and fudden re-action of the external objects upon their functions, and efpecially the union of the digefting, circulating, refpiring, moving, fentient, and generating organs. It has been thought, not without fome foundation, that the immenfe tribes of which thefe fix claffes of animals confift, form amongft themfelves a continued feries, an uninterrupted chain of beings, connected by relations more or lefs clofe, and defcending, by almoft infenfible gradations,

 from

from man, the model of animals, down to the polypus, the microſcopic animalcules, and the ſponge. The conſtruction of this chain has much occupied the naturaliſts, eſpecially Bonnet; and if their inveſtigations have not intirely anſwered their wiſhes, they have at leaſt had the advantage of enabling them to compare theſe beings with more accuracy, and to find between them relations which would not otherwiſe have been ſuſpected.

Article II.

Of the Functions exerciſed by the Organs of Animals.

1. IN the preceding article I have only ſpoken of the general ſtructure of animals, of their parts, and of their organs, in order to point out their differences from the vegetables which they otherwiſe reſemble in ſome general properties. It was a general notion of their anatomy which I wiſhed to give; but this ſuccinct account of their organization, repreſents as yet only the inanimate machine, and as it preſents itſelf to the ſcalpel of the anatomiſt. We ſhould have only a very imperfect idea of theſe beings, if we did not conſider their animated machine, if we did not ſee their parts

re-acting

re-acting the one upon the other, and actuated by the motion which the living force communicates to them. In presenting a sketch of the exercise of this force, in a narrow compass, I have no other intention than to ascertain the real characters with which animals are endowed, instead of proceeding blindfold in the examination of their chemical properties, which are to occupy this section.

2. The animal coming out of an egg, or the womb of its mother, after having received, by the fecundation of its germ, the motion which animates it, and after having experienced in its membranes, either during incubation or in the uterus, the first developments which mark out its traits, and determine its species, and even variety, fulfils a destiny which all mankind observe in the living beings. To be born, to increase in bulk, to acquire its full growth, to remain for some time in this perfect state, to re-produce beings resembling itself, afterwards to decline, and gradually to lose a part of its forms, its powers and its strength, lastly to perish in consequence even of the efforts which have supported its existence:—this is the circle which Nature has marked out for it, and which comprehends the duration as well as the principal events of its life. She has placed in it a power which causes it to desire, to take and digest its nourishment, soon to assimilate it with its own substance, to augment the mass of its body, to repair its waste, to carry the super-

 fluous

fluous parts into certain refervoirs, and efpecially into thofe which ferve for the purpofes of generation, and to reject a fuperabundant or unaffimilable portion by canals deftined for this ufe.

3. This principal effect of life fuppofes a difcernment, an appetite, a judgment, which require an immediate communication between the body of the animal and all the beings which furround it; fo that it can reject, remove from itfelf, take, or approach to itfelf thofe beings, accordingly as they are beneficial or hurtful to it. In this exercife of its life, all the organs which conftitute the animal, all the fyftems which form the totality of its texture, act fimultaneoufly, with order, with confiftency, with regularity, and each fulfils a particular function. The affemblage and defcription of thefe functions compofe what is named animal phyfics, or phyfiology. Ten functions are reckoned to prefide over life, which may be diftinguifhed, efpecially when it is propofed to exhibit their fimple refult, into four claffes.

The firft clafs comprehends the functions which immediately fupport life, and which were formerly called *vital* functions, becaufe the ceffation of any of them produces the inftantaneous death of the individual; thefe are the *central fenfibility*, *refpiration* and *circulation*.

The fecond clafs comprehends the functions, which immediately fupport life, or which prolong

long its exiſtence and duration; they have been called *natural* functions; they may be ſtopped for ſome time without life being deſtroyed. Such are *digeſtion*, *ſecretion*, *nutrition*, *oſſification*.

To the third claſs belong the functions which render life animated, re-acting in ſome meaſure upon the ſurrounding bodies, which eſtabliſh direct communications between the living animals and the beings which ſurround them; theſe diſtinguiſh the animal the moſt from the vegetable; they conſtitute its ſuperiority; they are *irritability* and *exterior ſenſibility*.

Finally, I rank in the ſixth claſs the function which communicates life, which perpetuates the ſpecies; this is *generation*. I ſhall preſent a ſketch of the phenomena of each.

4. By *Central ſenſibility* I diſtinguiſh the function of the cerebrum, of the cerebellum, and eſpecially of the medulla oblongata, which ſeems to be the primum mobile of all the others, the perfect integrity of which is indiſpenſable to life, at leaſt in the animals in which theſe important organs are well conſtituted. It has ſuch an influence upon all the functions, that none of them can exiſt unleſs it be in its complete plenitude. Thus in man, in the mammalia and in the birds, a very ſlight preſſure upon theſe organs renders the individual ſoporoſe, paralytic, weakens, alters, or annihilates his external ſenſes; a too ſtrong preſſure, a puncture a little deep, an inciſion, or a wound which penetrates to

the centre of the medulla oblongata, destroys life as suddenly as lightning. Thus an animal is instantaneously killed by thrusting a small knife between the first vertebræ and the occipital. The cause and the mechanism of this eminently vital function are entirely unknown, as is almost every thing that appertains to the living properties of the medullary pulp of the cerebrum, of the cerebellum, of the medulla oblongata.

5. *Respiration* is not a function immediately vital in all classes of animals; it has this character only with those in which the blood is obliged to pass through the respiratory organ previous to its being sent into all the regions of the body, as in man, in the mammalia, and in the birds. With the others in which the blood is not obliged to follow the course that has been indicated, at every moment of life, respiration may be retarded, interrupted, partial, momentaneous, periodical, or in general irregular. Its purpose is to bring the blood, either wholly or in part, at every instant, or at certain intervals into contact with the air and aërated water. The lungs in man, in the mammalia, and in the birds, the gills in fishes, the tracheæ in the insects and worms, are the organs of this function. It consists in two alternate motions, the one by which the air is received, or *inspiration*, the other by which the air is evacuated, or *expiration*; an effect takes place between the air and the blood, which modifies

the

the latter and renders it adapted for life, and the nature of which chemistry, as shall be seen, teaches us to determine. It contributes to support the circulation, which, in a great number of animals would not take place without it. The diaphragm, the ribs, the muscles attached to them, exercise its motions in the most perfect animals, in the birds it is still more energetic on account of the organs accessary to the lungs, which, with them, extend into their bones and their feathers. It extracts the air from the water in fishes, which cannot live in water that has been boiled.

6. *Circulation* is the motion of the blood from the heart into the arteries, and from these into the veins, which carry it back again into the heart. It takes place in animals without interruption. The heart is endowed with a great force for expelling this liquid, which, as it dilates the arteries, causes them to pulsate: this first order of vessels possesses a power of contraction which propels the blood into the last ramifications; the veins do not possess the same power; the blood is propelled in them by the side which presses it, by the valves which prevent its retrograde motion, by the vacuum which its progress produces, by the pressure of the adjacent parts and especially of the muscles. This function is two-fold in man, in the mammalia and in the birds; the one is pulmonary, and carries the blood by a short passage from the right to the left cavities of the heart; the other, which

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is general, carries it from the latter cavities into the whole body, and brings it back to the right ſide: theſe two circulations form together a route, which is pretty well repreſented by the type or figure 8. In the animals placed below the birds, the heart has not the ſame number of cavities, and the blood does not take exactly the ſame courſe; reſpiration is not neceſſary to the integrity and the continuity of its circular motion; the cavities, the canals through which it paſſes, the courſe which it takes, vary, and deſcend, in ſome meaſure through a ſcale of degradation down to the loweſt claſſes of animals. The three inferior claſſes, the teſtacea, the inſects, and the worms, have white cold blood, a heart imperfectly organized, or a dorſal veſſel which ſupplies its place, an irregular and very feeble circulation. The zoophytes, the laſt claſs, have neither heart nor circulation.

7. Digeſtion conſiſts in the introduction of aliments into a canal or ſac in which their nature is changed, they become ſoftened, diſſolve and ſeparate into two ſubſtances: the one, the chyle, which paſſes into the veſſels in order to renovate the blood, and ſerve for nutrition; the other which paſſes out of the body in the form of excrement. This function is very much varied, both with reſpect to its organs and to its reſults, in the different claſſes of animals, and frequently even in different genera of the ſame claſs. We may, however, diſtin-

distinguish in it four periods: the first, the preparatory, comprehends the bruising, mastication and deglutition; the alimentary bolus is formed and conducted into the stomach in this first period; the second, which comprehends the digestion in the stomach, or the change of the alimentary matter into chyle, or homogeneous pulp; the third, which belongs to a second change produced in the intestine, and which separates the chylous matter from the excremental; finally, the fourth, which comprehends the absorption of the chyle that has been formed, by the lacteal vessels, and the expulsion of the excrement.

These four periods are very distinct in man, in the mammalia, the birds, the reptiles, the fishes, and the insects. They present in them a multitude of modifications, determined by the form of the organs of manducation, deprived of teeth or provided with teeth of very different kinds, destined for bruising, tearing, cutting; by that of the stomach, simple or quadruple, or divided into craws, of the gastric juice more or less dissolvent or weak; by the nature and the quantity of the bile and of the pancreatic juice, which form the second digestion, and effect the separation of the digested aliments into a chylous part and an excrementitious portion; by the very various length of the intestinal tube, which in general is short in the carnivorous, and very long and contorted in the frugivorous and granivorous animals; by

by the form, the size, the texture, the secretory force of the pancreas, of the liver, &c.

This function has not the same distinct periods in some insects, the testacea, the worms, and especially the zoophytes. With the latter, it is merely a simple passage of the aliment into a sac or a tube, in which a suction, equal in all points, is performed.

8. *Secretion* is so termed because it is supposed to separate different humours from the blood. It is performed by the glands; it is in this manner that the saliva is separated in the salivary glands, the bile in the liver, the urine in the kidneys, the pancreatic juice in the pancreas, the synovia in the articular glands, the sperm in the testicles, &c. &c. It is, however, not a mere separation, which would presuppose that each of these liquids was contained ready formed in the blood; but a real particular change of the latter in each gland, as I shall show at the close of this section. There is no function in animals which is more general, more extended and more varied than this. It presents a multitude of particularities in the classes, the genera, and even the species of these organized beings, according to the particular wants of the species. It constantly consists in a preparation of the blood before it arrives at the secreting organ, in its change and in the separation of the matter secreted in the interior of this organ itself, and in the exit or ejection of this humour, frequently effected by an excre-

tory duct. This latter circumſtance is owing to the vital action, a kind of irritable motion of the excretory duct, which experiences an orgaſm, a very well marked erection, at the contact or at the mere ſight of the ſtimulant appropriate to it, as the ſaliva which runs and guſhes out of the ſalivary ducts, at the ſight or even at the mere idea of the aliment that excites the appetite, &c.

9. *Nutrition* is the end of digeſtion and aſſimilation. The alimentary matter converted into chyle, poured in this form into the blood, aſſimilated by its mixture with this liquid, vivified by reſpiration and circulation, is carried by the latter into the different organs; it depoſits in each the ſubſtance proper for exactly ſupplying the loſs which it has ſuſtained. It is changed eſpecially into lymph, which being tranſported into every part and into all the cavities, all the cells of the cellular texture, furniſhes there that mucous, plaſtic jelly, diſpoſed for forming the tranſparent and gelatinous laminæ of which moſt of the animal ſubſtances are formed. On this account the lymph has been appointed as its nutritious baſe, and the mucous texture as its ſeat or organ. However, the idea of nutrition muſt be ſtill more generalized; and each muſcular, pulpy, membranous, parenchymatous, oſſeous organ, conſidered as poſſeſſing the property of appropriating to itſelf, in the blood and the lymph which paſſes through and penetrates it, the matter deſtined

for

for its own repair. In fact, the excess of this nutriment is taken up again, with the part of the organ in some measure worn and melted, by the absorbent vessels, which pouring it into the tide of the circulation, renew or transport it outwards by transpiration. The nutrition is much more active in the first periods of the life of the animal, when its organs, which are dilatable and extensible to a determined degree, grow till they have attained this term. On this account the digestive powers are at that period of life more energetic, the appetite keener, and the quantity of aliment required more considerable. It is modified in the different classes of animals according to their nature, and very simple in the last.

10. *Ossification* deserves to be considered as a particular function, on account of the important part which it acts in the phenomena of life; the formation of the bones in the first periods of the life of animals has a great influence upon their existence and their strength. Though this is really nothing more than a secretion of osseous and solidifiable matter, in the gelatinous organ, which forms the base of the bones, this secretion is so general, it holds such an important place in the animal economy, that it ought to be considered and studied in particular. The bones, after having been membranous in the first formation of animals, becomes solidified at their centre and in divergent rays in the flat bones; in three points, at their middle and

and their two extremities, in the long bones; in the latter the bones remain for some time separated from the body of the bone under the name of epiphyses; they do not glue themselves together till about a sixth of the period of life has elapsed. Towards the period of old age, the bones become more brittle, because the proportion of the solid salt increases in them. These organs, the totality of which constitutes the skeleton, do more than give form, extent, and support to the different parts of the body of animals. They are also levers moveable upon each other, which cause these parts to assume various situations with respect to one another, which favour locomotion, which serve for the execution of all the motions and the action depending thereon. We might therefore refer ossification in this point of view to the class of functions, which establish a communication between the animals, and the bodies which surround them.

11. *Irritability* is one of the animal functions which present the most wonderful circumstances and phenomena difficult to be comprehended. This name is given to the living power by which the muscles or the organs, which form the flesh of animals, contract themselves, change their dimensions, approach and move the bones one upon the other. Their contraction or the diminution of their length, and their dilatation in breadth and depth, their change of dimension in general, are effected by the aid of a stimulus, which is directed by the will,

will, and which ſeems to proceed from the focus of the central ſenſibility; they are executed by a motion, the cauſe of which is not known. We know that the concurrence of the veſſels and nerves is neceſſary, in order that it may take place in the animals in which the laſt-mentioned organs are found. It is alſo known that by eſtabliſhing between the nerves and the muſcles a communication with the aid of two different metals in contact with each other, we cauſe this motion to be produced at will, and this important phenomenon bears the name of Galvaniſm, becauſe it was diſcovered by Galvani, an Italian phyſician. Finally, all the experiments have ſhown that this function, which exiſts in all animals, is very energetic even in thoſe whoſe fleſh is white, and down to the Zoophytes, in which neither brain nor nerves have been diſcovered. A puncture, a bright light, or a cauſtic, excite contraction when they are placed in contact with the muſcles. It is to this grand property of the fleſhy fibres that all the motions of animals are to be attributed, from that of the heart which acts inceſſantly and without their participation, to that of the ſmalleſt of their muſcles, which they cauſe to act at will.

12. The exterior ſenſibility comprehends all the ſenſes placed in different regions of the bodies of animals, but more particularly in that of the face, where they are almoſt all united in a line very near to the brain. The ſtudy of this function, which preſents the organs and the ſenſations

tions of the fight, the fmell, the tafte, hearing, and touch, is of all the parts of phyfiology, that which prefents to the obferver the greateft number of remarkable facts, and the moft varieties in the ftructure and relative extent of each of the fenfations in the different claffes of animals. Thefe fenfations are in general perceived by the nervous extremities fpread out in a tranfparent jelly at the bottom of the eye, into fhort and pulpy filaments in the internal ear, into flat and long filaments in the noftrils, into projecting papillæ upon the tongue, and into foft and extremely numerous tubercles under the fkin. The impreffion made by light, by founds, by fmells, taftes, furfaces, is tranfmitted to the focus of central fenfibility by the nerves which propagate it to this focus, which is called the *fenforium commune*. The fentiment of pleafure or pain, which follows this tranfmiffion, and the comparifon of thefe different, fucceffive, multiplied, modified fenfations, gives rife to the ideas and produces all the voluntary motions deftined for the fupport of the life of the animal, by furnifhing it with the means of removing or avoiding that which is pernicious, and approaching or feizing that which is beneficial to it. None of the animals have, in the number and the relations of their fenfes, and confequently in that of their fenfations, the fame harmony and proportion which conftitute the perfectionable character of the human fpecies.

13. Generation,

13. Generation, the most incomprehensible and the most hidden of the functions of the body of animals, by perpetuating these beings, carries into these individuals which all proceed from the same stock, a resemblance of form, of structure, and of properties which rigorously determine the species. In this function we scarcely know the organs by which it is accomplished, and the result of their mutual action; even the mode of their exercise, the cause of their effects, the mechanism of fecundation, are covered with a veil the most obscure and impenetrable to man. Anatomy and physiology have nevertheless made numerous and important discoveries, and established some general truths concerning this mystery. They have shown that all the animals which exist have formed an integrant part of animals similar to those from which they have been separated; that this separation, this detachment of animals from their parents is effected in several different ways, that in the animals the most simple and the least complicated in their structure, there are formed, as in the vegetables, buds filled with small animals similar to those from which they proceed, and which detach themselves at a certain period of growth, or that a fragment of their substance separated from a first adult individual, forms an animal intirely similar to this, like the slips in plants; that in others, and those are the most numerous, the concurrence of two organs, the one under the name of ovarium, containing

containing the animal ready formed, but not animated and living, which is the feminine organ; the other containing a liquid capable of exciting by the flightest contact the motion of life in this embryo, which is the male organ; that those two organs neceffary for the fecundation and re-production, are fometimes united in one and the fame individual in fuch a manner as to render it either fufficient for itfelf, or to admit of a double production in each individual, which then is androgynous; that moft commonly the two organs are feparated in two individuals of the fame fpecies, which is termed *fex*, and that they require, for the purpofe of fecundation, their union or copulation; that this union of the two fexes is folicited by an imperious want, by an appetite more or lefs violent, which has its period in every year; that this appetite does not fhow itfelf thus except with the power of fatisfying it, and of engendering when the growth of the animal is completed, or when the animal is perfect; that it appears to arife from an excefs of nourifhment, of which the organs, which no longer grow, are no longer in want; that on this account it becomes more powerful, much more frequent, and has no longer any regular period when the animals are furnifhed with a very abundant and very fucculent nutriment; that when the act of fecundation has been performed, the embryo animated by the fpermatic liquor grows, either in the womb of the female, or out

out of it; that after a certain determined time it comes out of it, inclosed in a shell or membrane in the form of an egg, and that it now requires only a certain temperature in order to be hatched, as in the oviparous animals; that in the same manner, in the viviparous animals, the embryo, having become a fetus by fecundation, is developed in a given time, lives in the womb of its mother, immersed in a liquid, and inclosed in different coverings, and that it leaves the womb when it has acquired a certain growth; that when it has once left the egg or the womb, the young animal, in the first classes of animals, still retains for some time a particular structure in the organs of respiration and circulation; but gradually loses this difference, in proportion as it respires and nourishes itself after the manner of its parents; and that finally at the end of its growth, its being is completed and perfected to the period when the necessity of producing its like, of communicating the excess of life which it enjoys in all its plenitude, is felt with the last development of its organs.

ARTICLE

Article III.

Of the Succeſſion and of the Hiſtory of the Diſcoveries in Animal Chemiſtry.

1. HOWEVER rapid the ſketch of the ſtructure, and of the functions of animals, comprehended in the preceding articles, may be, yet it is ſufficient to ſhow the difference which exiſts between them and the vegetables; and though intended only to ſerve as an introduction to the examination of their chemical properties, it is alſo ſufficient to ſhow, that, notwithſtanding the difference which ſubſiſts between theſe two claſſes of beings, there neverthelefs exiſt between them a greater number of relations and analogies than are remarked between the plants and the minerals. In the inveſtigation of the real differences which ſeparate theſe two orders of organized beings, the labours of chemiſts have not been fewer than thoſe of the anatomiſts, and if the ſucceſs of their experiments has been inferior to that of the deſcription and knowledge of their organs, modern chemiſtry has ſupplied this deficiency, which depended only upon the imperfection and the inaccuracy of the means and inſtruments which ſhe has poſſeſſed only for ſome years paſt. It will

be an inquiry, no leſs curious than uſeful, how this ſcience has arrived at the point of perfection which it has now attained in this kind of analyſis, through what ſtages it has paſſed, and what may ſtill be expected from it, from the light which it has already thrown upon animal phyſics.

2. The ancient chemiſts, occupied in the ſearch of imaginary. properties, in moſt of the natural productions, either for the chimera of the opus magnum, or for the treatment of diſeaſes, have given nothing but erroneous notions concerning the animal matter. Their decompoſition by fire was the only method which they followed, and the ſource of theſe errors. Nothing uſeful is to be found before the middle of the ſeventeenth century. Few chemiſts even occupied themſelves with them, either on account of the diſagreeableneſs and fetidity of this analyſis, or on account of its difficulty, or laſtly on account of the ſum of collective knowledge which it required, and the few chemiſts whom it intereſted, in times when all were zealouſly engaged in the examination of the minerals. I divide the hiſtory of animal chemiſtry into eight epochas, each marked by ſome great diſcovery which characterizes it, more than by the time in which each of them can be fixed.

3. The firſt epocha, which dates from the middle of the ſeventeenth to the beginning of the eighteenth century, is remarkable by a kind of

of invasion which chemistry made into medicine, by introducing into it its ridiculous theory of the acids and alkalis. It succeeded the chimeras of the panaceas, the elixirs of life, and potable gold, which the alchemy of the adepts had before introduced into the practice of the art, which at least was corrected by the beneficial acquisition of the mercurial and antimonial remedies, of opium, &c. Tachenius, Willis, Vieussens, Sylvius, were the most celebrated propagators of chemical medicine, founded upon the acids and alkalis. The functions of animals, according to them, were performed by effervescences and fermentations; the acid and the alkaline humours mixed and contended together; maladies arose from the excess of the one or the other, and the therapeutic art combated them with remedies of a contrary nature. The art of healing was for some time infected with this error, which was destroyed only by the rise of experimental philosophy.

4. I attach the second epocha to the efforts which some great physicians, equally illustrious by their knowledge of chemistry, were obliged to make in order to destroy the absurd and pernicious ascendancy which the theory of the acids and alkalis had assumed in the art of healing. After the first successes of experimental philosophy; after the great revolution effected in the sciences by a Bacon, a Newton, and a Boyle, Stahl and Boerhaave occupied

 themselves

themſelves with liberating medicine from the errors which hypothetical chemiſtry had introduced into it. They were obliged even to rate its uſe in the art of healing almoſt as an abſolute nullity, in order to combat the predominant theory; they appeared almoſt to deſpiſe the important labours and firſt outlines of Mayow, Boyle, and Hales, who had borrowed from chemiſtry new means for advancing animal philoſophy, in order to repel the noxious invaſions which it had made in the healing art. Their great influence upon thoſe who taught, ſtudied, and practiſed medicine, had all the ſucceſs which they aimed at; and it was believed that chemiſtry could have no other uſe in medicine than that of furniſhing new remedies, or improved modes of preparing them. This ſecond epocha dates from the commencement of the eighteenth century to nearly a third of its duration. The theory of the acids and alkalis was overturned and ſoon forgotten.

5. The third epocha in the hiſtory of animal chemiſtry, dates from the moment when the operation of the phoſphorus of urine, found accidentally in 1677 by Brandt, diſcovered ſome years afterwards by Kunckel, prepared for a long time excluſively in the laboratory of Godfrey Hanckwitz, at London, for all Europe, was taught at Paris by a foreigner, and deſcribed in 1737 by Hellot, in the Memoirs of the Academy of Sciences. This proceſs, though tedious, difficult, expenſive, and diſguſting,

was the ſignal of the revival of animal chemiſtry, which then was almoſt intirely neglected. Chemiſts began zealouſly to labour upon urine. Margraff found that the *microcoſmic* or *fuſible* ſalt, the phoſphate of ammonia, was the ſource of its phoſphorus; that it did not proceed from marine ſalt, as Stahl had aſſerted; he gave an excellent proceſs for preparing it, by means of the muriate of lead, added to the extract of urine, and which ſerving to decompoſe, without his knowing it, the phoſphate of ſoda, greatly augmented the quantity of phoſphorus obtained: he even found, if not the real difference of theſe two ſalts, yet at leaſt that there were two different ones in urine. Pott, in 1740 Haupt and Scheffer, in 1753, alſo deſcribed the properties of the fuſible ſalts or phoſphates; Haupt even diſtinguiſhed the phoſphate of ſoda by the name of *pearled ſalt*. Rouelle the elder, who commenced his lectures at Paris about this period, not only ſucceeded in making phoſphorus for ſeveral ſucceſſive years, but began to multiply his reſearches and his products upon the animal matters. In glancing over the proceſſes of his courſe of lectures, publiſhed in 1762, we find that he had cauſed this department of knowledge to make much greater progreſs, than it preſents in the works of his predeceſſors, eſpecially in thoſe of Boerhaave.

6. The fourth epocha in this department of chemiſtry, ſtill ſo new and ſo little cultivated, is pretty accurately fixed by the labours of

Rouelle

Rouelle the younger. Educated for a long time in the school of his brother, possessed of the notions of this learned chemist, accustomed especially by long practical studies, to make more exact and more precise analyses than had been made before, distinguished amongst all the chemists of his time, by his great and valuable skill in distinguishing bodies, and separating them ably from each other; he particularly occupied himself with animal chemistry, for which he seemed to have acquired a peculiar predilection. He published successively in the Journal of Medicine of Paris, from the year 1773 to 1777, numerous and new inquiries concerning the salts of the blood, the water of hydropic patients, the human urine, the urine of the cow and the horse, compared with each other, concerning the sugar of milk, concerning the blood, concerning the fusible salts, and concerning the urine of the camel. He confirmed the discovery, made in Italy by Menghini, of the presence of iron in the blood. All his analyses, described with ability and simplicity, given without forced applications to medicine, presented new truths, which diffused a light over several points of animal philosophy. The physicians availed themselves of them, as well as of those of Citizen Cadet upon the bile, which he proved to be a soap, in the year 1766. Bucquet advanced a little further in the art of analysing the blood. Poulletier de la Salle announced some new facts concerning a concrete

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and cryſtalline ſubſtance contained in biliary calculi. The wiſe and reſerved progreſs of all theſe labours, recalled the mind to the advantageous uſe of animal chemiſtry, and the aid which it offered to the art of healing. Succeſsful reſearches were then made into the characteriſtic differences between the chemical properties of animal and vegetable ſubſtances. Several animal acids were diſcovered; and the preſence of the phoſphoric acid in ſeveral of the animal humours was aſcertained. In a word, chemiſts became inſpired with new courage, and this kind of analyſes aſſumed a luſtre which it had never exhibited before.

7. The fifth epocha which I diſtinguiſh, is remarkable for three extremely ſtriking diſcoveries relative to the animal analyſes, made in Sweden during the ſame time that belongs to the preceding, but known ſomewhat later in France. In 1772, Scheele, a Swediſh apothecary, and Gahn, doctor of medicine in the ſame country, diſcovered the phoſphoric acid in the bones of animals, the ſolid matter of which they aſcertained to be phoſphate of lime, and deſcribed means for ſeparating from them theſe ſubſtances, which till then they had not even been ſuſpected to contain. Rouelle the younger, Nicolas de Nancy, Berniard, Poulletier de la Salle, and Macquer, confirmed this diſcovery, and added ſeveral important facts, with regard to the comparative nature of the bones of different animals, and the proceſs of their analyſis.

This salt has been found amongst the fossils, and afterwards the chrysolite was discovered to be composed of it. Scheele announced, in 1776, that the same salt, the base of the bones, existed in the human urine with an excess of phosphoric acid which rendered it soluble. In the same year, and in the same Memoir, the Swedish chemist discovered a particular acid in the calculi of the human bladder. It was then, that by comparing these three capital discoveries with several facts of physiology and pathology, it became generally acknowledged that chemistry, treated in this manner, might be applied with great utility to the art of healing, and that so far from there being any reason to apprehend the errors which had already endangered its fate, on the contrary, its important applications could no longer be dispensed with.

8. At the same time nearly, and confounding itself with the preceding, though deserving to be distinguished by its object and its views, is placed a sixth epocha, not less important than any of those that have been indicated. It is constituted by the first data which the pneumatic doctrine, still in its infancy, afforded to the chemistry of animal matters. Lavoisier, while operating in the year 1774, upon the analysis of the air, ascertained with precision the ancient, but vague comparison which had been made between the respiration of animals and combustion, and found that it altered the

air

air after the manner of charcoal. Condorcet then gave the name of vital air to the refpirable part of the air. Crawford found in refpiration, and in the air, which is fubfervient to it, the fource of the animal heat. Carminati difcovered that the mephitis, in rendering animals infenfible, deftroyed the irritability of the heart and of the mufcles. Lavoifier was fucceffively led to ftudy, with Citizen Seguin whom he took as the affociate of his refearches, the phenomena and the influence of tranfpiration, and to afcertain that a great analogy fubfifted between this function and refpiration. Citizen Spallanzani at the fame time made a kind of living analyfis of the gaftric juice, and confirmed its diffolvent quality, which had been already proved in 1743 and 1744 by the ingenious Reaumur; he alfo difcovered in it a ftrong antifeptic power. This new career, which, it is evident, deferves to form an epocha in the hiftory of animal chemiftry, has not finee been interrupted. It has diffufed the cleareft light over the phyfical nature of animals, and proved that phenomena, which are truely chemical and appreciable, take place in the exercife of their functions. It is in fome meafure a living chemiftry, which Mayow had a glimpfe more than a century ago, which was purfued in fome points by Hales at the beginning of the eighteenth, and refumed in our time by its relations equally effential and immediate with the principal phe-

nomena

nomena of the pneumatic doctrine which ſtand in ſo natural a connection with it.

9. The ſeventh epocha, which is ſtill more important than the preceding, on account of the greater number of objects diſcovered, or at leaſt illuſtrated, which it includes, and the generality which it embraces, relates intirely to the reſearches of Citizen Berthollet. This illuſtrious chemiſt, after having embraced, in the year 1784, upon the diſcovery of the compoſition of water, for which we are indebted to Lavoiſier and Citizen Monge, the pneumatic theory which appeared to him to be confirmed by this diſcovery, advanced animal chemiſtry a new ſtep forwards, by fixing the nature of ammonia which Scheele had only ſuſpected, and by diſcovering in animal ſubſtances a large quantity of azote. Ammonia being deciſively aſcertained to be a compound of five parts of azote and one of hidrogen. Citizen Berthollet ſhowed how it was formed ſo often by the action of fire, by putrefaction, &c. in animal ſubſtances ſo highly charged with azote. He proved, moreover, that the preſence of the phoſphates, and the abundance of hidrogen amongſt their principles, contributed greatly to this difference. There is eſpecially in this new ſet of data, which we owe to the French chemiſt of whom I ſpeak, and in the epocha which I conſider them to conſtitute, a character by which it ſenſibly differs from the preceding epochas; namely, that this ſeventh epocha preſents

fents a more general and more complete totality and refult than the others; that it refers not merely to a fingle fubftance or to feveral animal fubftances in particular, but to all thefe fubftances at once; that this inveftigation having afforded a knowledge of the whole mafs of animal compounds, thofe which have followed it have acquired a certainty, precifion, and ftability, which they could not have had without it, as will be proved by the expofition of the eighth and laft epocha of this hiftorical fketch.

10. This eighth and laft epocha comprehends the combination of the labours already indicated in the feventh, and the application, fince become more immediate and more eafy, of the analyfes to the phyfical Philofophy of animals, with the uninterrupted fuccefs of thefe applications, and the real exiftence of a new career, proper for explaining the moft obfcure phenomena of this philofophy, provided it be conftantly purfued. It is efpecially from 1777 and 1788 that this epocha ought to be dated, and it extends to the prefent moment. We find in it new and valuable analyfes of milk and blood by Citizens Deyeux and Parmentier, of the fynovia and of the humour of veficatories by Citizen Margueron, of the liver of cartilaginous fifhes by Citizen Vauquelin, of the human fperm by the fame chemift, of the faliva by Mr. Siebold; the difcovery of a new animal acid, formed by diftillation, and called zoonic acid by Citizen Berthollet. I, in particular, have

have not ceased, in this last epocha, to continue, availing myself of all the new means afforded by the pneumatic chemistry, the series of researches which I long ago commenced upon almost all the animal substances, for the most part with the assistance of my friend and pupil Citizen Vauquelin; I have published a great number conjointly with him; and some of them are peculiar to myself. A rapid enumeration will be sufficient to afford an idea of them; the conversion of bodies buried in the earth into a fatty matter, combined at first with ammonia, the resemblance of this fatty matter with spermaceti, and with the lamellated and concrete part of biliary calculi; its generality or its abundance in most animal substances, which has induced me to consider it as one of their most constant products, and to designate it by the name of *adipocire*; the proportion of azotic gas disengaged by the nitric acid from different animal substances compared; the existence of this gas in the air-bladders of carps; the presence of gelatin and sometimes of bile in the blood; the concrescibility of the albumen, owing to the fixation of oxigen, and the varieties of this humour, dependant upon the proportion of this principle; the presence of the phosphates, and especially of that of lime in many of the animal liquids, in which it was not known before, particularly in milk; the absence of phosphoric acid in the urine of infants; the calcareous benzoate which supplies the place of the

the phofphate of lime in that of the herbivorous mammalia; the analyfis of the tears and of the nafal mucus; their catarrhal thickening by the oxigenated muriatic acid; the analyfis of the inteftinal calculi of horfes, fince confirmed by Citizen Bartholdi of Colmar; that of the renal and vefical calculi formed by the carbonate of lime, which admits of the lighteft and weakeft acids as lithontriptics; the horns, the hair, the tranfpiration of thefe animals, containing and evacuating the phofphate of lime; the production of the Pruffic acid by the diftillation of the human calculi; the fame, formed in the treatment of all thefe animal matters by hot nitric acid; the inftantaneous formation of ammonia in all thefe matters treated by the cauftic alkalis; that of water, when they are treated in the cold by the concentrated fulphuric acid; the partial decompofition of the phofphate of lime by the acids, the formation of the acidulous phofphate of lime and not the fimple and pure difengagement of the phofphoric acid: fo that by the proceffes hitherto given, we do not by far obtain the whole of the phofphorus contained in bones; a new analyfis of the calculi of the human bladder, which has proved the prefence of four fubftances which were not known to exift in them, and which fingularly vary their nature; namely, of the ammoniaco-magnefian phofphate, of the combination of uric acid with ammonia, of the oxalate of lime in the mural calculi, and of filex, the

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most rare indeed of these calculous matters; the ascertaining the real solvents of calculi, and their necessary diversity according to the nature of these concretions; a more profound examination of the human urine, and the discovery of the ammoniaco-magnesian phosphate which is formed in it, as also of a particular matter which gives to this liquid its characteristic properties, and which I call urée; the medicinal action of the oxigenated substances, so much applied to since by several English Physicians; the preparation of fat surcharged with this principle, employed at present with so great success by one of my pupils, Citizen Alyon, who has particularly followed up my first views relative to this subject, and has carried them very far: such are the principal researches in which I have been engaged since the epocha when my friend Berthollet, by his important discoveries, fixed the progress of animal chemistry, which till then had been uncertain and wavering.

11. Though this is not the place to show how all these labours and discoveries have influenced the progress of Animal Philosophy and the art of healing, it will be easily conceived, from the simple and precise sketch which I have just presented, how many useful applications must have been derived from their results, and what great advantages they promise to medicine. It is evident that this is the only manner of determining the differences which subsist between

tween the different animal ſubſtances, of explaining their formation, and the alteratíons of which they are ſuſceptible; of furniſhing to Phyſiology what the moſt minute anatomy and the moſt exact and multiplied obſervation of what paſſes in living animals could never afford, as theſe two means are ſo ſoon exhauſted. Moreover, theſe firſt data, already ſo important and ſo uſeful, are the fruits of the labours of only a few men. Unfortunately, the number of labourers is very inconſiderable in proportion to the immenſe reſearches which this part of chemiſtry requires, and the multitude of queſtions to be ſolved which it preſents. Scarce a twentieth part of the chemiſts whom Europe poſſeſſes direct their views to this object. What will it be when, having become more univerſally diffuſed, more familiar, and preceded by all the intereſt which they ought to inſpire, theſe grand reſearches ſhall be multiplied; when hoſpitals appropriated to this uſeful inveſtigation ſhall have aſſumed the activity which their importance claims; when the phyſicians ſhall no longer neglect their opportunities of analyſing the morbific matters, &c.

12. It is then that all the hitherto incoherent parts of the new diſcoveries relative to animal chemiſtry will be approximated and linked together, by relations which yet can only be partly foreſeen and ſuſpected; it is then that a monument will be raiſed for which we are as yet only collecting the firſt materials. Some

 perſons,

perſons, indeed have already been too precipitate in making applications of the modern chemiſtry to the art of healing; they have been too haſty in forming from them a medical ſyſtem, either of the nature of diſeaſes, or of the employment of remedies. Whatever zeal theſe firſt attempts may indicate in their authors, they are, however, to be cenſured for an exaggeration equally detrimental to both of theſe ſciences, which they have attempted to connect together by premature approximations. They are not, as formerly, chemiſts properly ſo called, who have ventured upon this enterprize; theſe theoriſts are not thoſe particularly to whom we are indebted for the moſt connected inveſtigations, the moſt numerous experiments, the recent diſcoveries upon the animal matters, who have attempted to form a chemical ſyſtem in medicine. Rouelle the younger never propoſed any thing of this kind; Scheele has only given an account of the particular facts which he diſcovered; Citizen Berthollet to whom we owe ſo many and ſuch ingenious labours in this new province of chemiſtry, has allowed himſelf only to make ſome particular applications of them; and if I may be permitted ſtill to quote myſelf here, after the reſearches relative to this department of the ſcience, in which I have been inceſſantly engaged for nearly twenty years paſt, I have never even attempted to eſtabliſh a general theory. I am thoroughly convinced that the efforts of chemiſtry will hereafter change

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the aſpect of medicine, that they will produce a happy revolution in this as well as in all the other departments of phyſics: but this period has not yet arrived, and too many deficiencies ſtill remain for theſe changes to be admitted. I ſhall carefully collect, at the end of this ſection, ſuch important applications as the actual ſtate of chemiſtry permits to be made to animal philoſophy, to which I ſhall at the ſame time ſubjoin ſeveral new proſpects, which naturally preſent themſelves: but ſo far from forming a complete ſyſtem, it will be ſeen that they only prove the neceſſity of continuing our inveſtigations and not relinquiſhing a ſeries of inquiries which will hereafter conduct us to the deſired end.

Article IV.

Of the General Reſults of the Modern Experiments upon the Animal Compounds.

1. THE labours of the modern chemiſts upon animal chemiſtry have not been confined to adding a more or leſs numerous ſeries of new facts or of inſulated diſcoveries to thoſe which had been made before them; they have more eſpecially conducted philoſophers to general reſults reſpecting the nature of the animal compounds.

 It

It is even in this circumstance that the real difference between the epocha of the pneumatic chemistry and those which had preceded it consists. Till then the ancient chemical facts presented neither a general coincidence, nor data that could be applied to all animal matters; they formed truths unconnected with one another; they admitted of none of these approximations which really constitute the science, and without which it does not exist.

2. One of the principal objects of these labours has been to examine with attention the analogy announced after Boerhaave between the animal and the vegetable compounds. They have been found to resemble each other in their complication; they have been considered as substances which, having at first been vegetable, have acquired in the bodies of animals, and by their vital powers, a more complicated composition. Since that time we have been able to consider the organs of animals as chemical instruments, destined for uniting a greater number of principles together than the vegetable instruments; provided, however, that they should act upon compounds at least ternary, already previously formed in the organic texture of the plants; for observations easily show that no mineral substance can be changed immediately into animal matter in the bodies of animals.

3. In order to establish this comparison, which ought, however, to conduct us to the deter-

determination of their differences; after having reprefented the animals as formed, like the vegetables, of immediate principles, in the enumeration of which an extractive matter has been found in the flefh, &c. a gelatinous mucilage in the membranes and the bones, anfwering to the vegetable gum, a fugar of milk anfwering to the fugar of plants, fats reprefenting their fixed oils, refins, particular acids, and the albumen refembling the gluten of flour; it was very natural, immediately after the labours of Rouelle, that we proceeded to confider the animal matters as real immediate materials of vegetables, modified only in fome of their properties.

4. But without entirely rejecting every part of thefe analogies, it was foon found that they ought not to be admitted in too ftrict a fenfe; that they exhibit perhaps more differences than refemblances between thefe two claffes of bodies when compared with each other; that none of thefe immediate materials could be rigoroufly judged to be of the fame nature; that the more attentively they were examined, the more diftinct characters they were found to poffefs; that thus the immediate materials of vegetables which pafs into the bodies of animals fpeedily acquire in them, and by the flighteft exertions of the vital power, properties very different from thofe which they originally poffeffed. Befides which, the different fubftances entering into the formation of the body of ani-

mals were ſubject, as immediate materials, to a more eaſy ſeparation, becauſe they are more inſulated from each other and more diſpoſed to ſeparation, it was alſo found, that ſuch of theſe materials as appeared to be the moſt ſimilar to ſome one of thoſe of the vegetable, nevertheleſs differed from it much more in its intimate nature, and conſequently in the phenomena which is preſented in chemical experiments than had at firſt been imagined.

5. The changeableneſs of the animal matters already verified long ago, announced that their more complicated compoſition was the principal cauſe of it; we began clearly to conceive why they were leſs permanent than the vegetable ſubſtances, why they were decompoſed more eaſily and more ſpeedily, why their changes were more rapid, and why they never remained in the ſame ſtate. The number of their primitive principles being greater, had it been augmented only by a ſingle one more than the three which have been well aſcertained in the vegetable compounds, namely carbon, hidrogen, and oxigen, —the ſingle addition of azote to theſe three firſt conſtituent elements of the vegetable alimentary matter,—an addition produced by the phenomena and the powers of life, is ſufficient to enable modern chemiſts to explain their changeableneſs, by calculating the multiplicity of attractions to which this number of the principles muſt give riſe.

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6. This laſt notion, acquired chiefly from the diſcovery of Citizen Berthollet, conducted me to another not leſs general or leſs important, relative to the animal matter; namely, that when deprived of the azote with which its compoſition is complicated, eſpecially by the action of diluted nitric acid, this matter ſeems to experience a retrogradation, and to return to the ſtate of vegetable matter, ſuch as it had been before it had undergone animalization. It is thus that I eaſily account for the abundant converſion of the animal compound into an acid ſimilar to that which is alſo produced by the chemical art in the vegetable matters; an acid which it affords even in greater abundance than the materials of plants do, as Citizen Berthollet had announced ſome years after the diſcovery of the preparation of the acid of ſugar, or the oxalic acid by Bergman.

7. The complication in the compoſition of animal ſubſtances, which is the common ſource of their differences, and at the ſame time of analogies with vegetable ſubſtances, does not conſiſt merely in the addition of azote, but alſo in that of ſulphur and of phoſphorus; theſe three combuſtible bodies, combined with carbon and hidrogen, are the common ſource of the fetid gaſes diffuſed by animal compounds during their decompoſition, by whatever agent it may be effected. The tendency which two of them have to aſſume the form of gas, and that which the three others have to

 diſſolve

diſſolve together or ſeparately and in very different proportions in the two former, are the cauſes of this fetor, which has always been acknowledged as one of the moſt marked characters of the animal ſubſtances.

8. We muſt alſo reckon amongſt the important reſults afforded by modern chemiſtry, relative to the compoſition of the animal ſubſtances, and their general differences, the preſence of the phoſphates ſo accurately eſtabliſhed by Scheele, by Citizen Berthollet, and by my own inveſtigations concerning thoſe ſubſtances. It will ſoon be ſeen, not only that theſe ſalts form ſometimes nearly the whole texture of ſeveral organs, that they give a more or leſs marked character to ſome of the liquids of animals, but alſo, that they act an important part in the chemical phenomena which both preſent to the obſerver; and that they give riſe to ſome of the principal properties which are diſcovered in them by analyſis. In this abundance of the phoſphates, conſiſts one of the moſt ſtriking differences preſented to the chemiſt by the animal compound compared with the vegetable.

9. Laſtly, we ought to refer to the totality of the modern diſcoveries, and to the new analyſis of animal matters,—we ought to rank amongſt their moſt valuable reſults, the knowledge which they have afforded concerning the proportion, or the relation of quantity, between the conſtituent principles of thoſe matters. Without this knowledge all the reſt would be barren,

barren, it is this which fecundates it by rendering it complete. It has been found that animal matters contain more hidrogen and lefs carbon than the vegetable, more fulphur and phofphorus, more phofphates with different bafes than the vegetable compounds; and that the converfion of the latter into the ftate of animal compounds does not confift merely in the addition of fome principles and the complication of their compofition confequent upon this addition, but alfo in the change of the proportion of thofe principles.

10. Thus the general refult of all the various labours upon the animal analyfis, that which includes all the other particular refults, which gives rife to them, and which is their common fource, fhows that animal matters are compounds, at leaft quaternary, formed by the union of hidrogen, of carbon, of azote, and oxigen, with which are frequently affociated, in very variable proportions, fulphur, phofphorus, lime, magnefia, and foda. Thefe compounds, lefs carbonated but more hidrogenated than the vegetable fubftances, are brought to the ftate of oxides by the oxigen they contain. The proportion of hidrogen in them being more confiderable, the azote being very abundant, the phofphorus and the fulphur frequently uniting in them their particular attractions, there refult from them, matters more or lefs combuftible, eafy to be decompofed, very alterable, very fetid in moft of their alterations,

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very much inclined to aſſume the oily character, and to furniſh ammonia. Theſe are the truths well eſtabliſhed by the new diſcoveries; and all that will follow this general expoſition in the preſent ſection will be only a development or application of theſe doctrines.

SECOND

SECOND ORDER OF FACTS.

Of the Chemical Properties or Characters of Animal Subſtances in General.

ARTICLE I.

Of the General Conſideration of this Order of Facts.

1. IT is not ſufficient to have enunciated in the preceding article the general nature of the animal compounds: to know what they are formed of in general, gives indeed a notion of their difference from vegetables, and of their particular mode of exiſtence; but this notion can only be conſidered as an introduction to their chemical hiſtory, or as a firſt means of arriving at the expoſition of the latter. It conducts us to it without being able to ſupply its want; it may precede it, but it cannot be ſubſtituted in its place. When once well conceived, it leads to the underſtanding of the real chemical properties of animal matters; but alone it will never conſtitute them; it muſt even demand that we ſhould paſs from the general conſideration of this compoſition to the exhibition of the properties of the animal matters.

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2. In fact, when we know the nature of the principles which enter into the composition of the animal substances, we may explain the phenomena which they present when placed in contact with different other matters; and it is those phenomena, and their manner of comporting themselves with the different agents by which they are treated, that constitute the chemical properties of these substances. There are two methods of considering these properties: we may either treat of those that belong to the totality of these substances, and are found in all in a more or less remarkable degree, or we may occupy ourselves with these properties with relation to individual animal matters; and these contain the characters which distinguish each of them in particular. The first constitute the object of this second order of facts: the others shall be examined in the third order.

3. As to the properties of the first kind, or those which belong in general to all animal substances, only a very small portion was formerly known of those which have been discovered within about twelve years past; chemists occupied themselves with scarcely more than one of the products obtained from them by the action of fire, and the phenomena which their putrefaction exhibited; namely, the production of what was called *volatile spirit* and *volatile salt*, and which, as we shall soon see, is only carbonate of ammonia by distillation. It was only by this character that animal substances were then

then diſtinguiſhed from the vegetable; but ſince the modern diſcoveries there exiſts a much greater number of diſtinctive characters; for the mode of action of moſt bodies upon the animal ſubſtances furniſhes as many characters proper for diſtinguiſhing them.

4. Though theſe general properties may now be very much multiplied, and divided into as many ſpecies as there are bodies that act differently upon the animal matters, it is eaſy to refer them to a certain number of heads, which I reduce into nine articles.

In the firſt, I ſhall treat of the action of caloric upon theſe ſubſtances.

In the ſecond, I ſhall examine that of the air.

In the third, that of water.

The fourth ſhall have for its object the action of the acids.

The fifth, that of the alkalis.

To the ſixth will belong the properties which animal ſubſtances preſent with the ſalts, and the metallic oxides and ſolutions.

To the ſeventh I ſhall refer thoſe which ariſe from the action of the vegetable ſubſtances.

In the eighth I ſhall examine the acidifiable property of animal ſubſtances, and the principal acids which they afford, eſpecially the Pruſſic acid.

Laſtly, the ninth article ſhall be appropriated to the examination of putrefaction.

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It muſt be evident that theſe nine titles comprehend the action of all the claſſes, or all the genera of bodies upon the ſubſtances with which I am engaged, and that ſuch a diviſion can leave nothing to be deſired relative to their general and characteriſtic properties.

Article II.

Of the Properties derived from the Action of Caloric upon Animal Subſtances in general.

1. CALORIC acts upon the animal ſubſtances by decompoſing them more or leſs rapidly, by changing the combination of their principles, by ſeparating from them products which did not exiſt as ſuch in theſe matters. This general action ſo far reſembles that which this agent exerts upon the vegetable ſubſtances; it reſembles it by tending alike to their deſtruction, by inſulating their principles, by uniting them in another order, by deſtroying the homogenous compoſition of which they were formed. But the analogy ſoon diſappears in a great meaſure, when we examine with attention what paſſes in this ingenious decompoſition; the phenomena are extremely different, and the greater complication of effects which take place are adapted to throw the greateſt light upon

upon the nature of their primitive compofition itfelf. The difcoveries to which the attentive obfervation of this phenomenon has given rife, and the influence which they have had upon our knowledge of the animal matters, are among the moft happy and moft ufeful refults of the modern chemiftry and the pneumatic doctrine, to which we are indebted for thefe difcoveries.

2. Though the action of a mild heat, and the introduction of a fmall quantity of caloric into the animal matters, is in general confined, as with the vegetable matters, to thickening their liquids, giving them the concrete form, drying their folids, extracting from the one as well as from the others, a more or lefs confiderable quantity of water, as it is obtained on the water-bath; yet this action, feeble as it is, prefents very remarkable differences, which become diftinct characters of animal fubftances. A gentle fire tends to coagulate thofe that are liquid, and this coagulation is accompanied with opacity and a change of nature; this is announced by the change of tafte, and by the infolubility in water which thefe coagulated matters acquire. The water, which is difengaged on the water-bath, is in part contained in thefe matters, and in part formed by the action of the fire; it has a particular faint tafte; it contains fome matters which give it the property of becoming turbid, of depofiting flakes, and of putrefying much more

more ſtrongly and quickly than that which is obtained from the vegetables. The animal ſolids, if heated not very violently, experience a change of colour, of conſiſtence, of tenacity, of ſmell, and of taſte, which is known by the name of *baking*, and proceeds from a commencement of alteration which has not yet been exactly determined.

3. The difference of the action of caloric is much more conſiderable, when we expoſe the animal compounds to a more active fire, and to the contact of combuſtible ſubſtances in the ſtate of inflammation or ignited to redneſs. We ſee theſe ſubſtances become agitated, contorted, and bend themſelves in different directions, ſo as to exhibit a remains of irritability, or mobility, to this decompoſing ſtimulus; we might ſay, that, though dead, they ſtill oppoſe ſome reſiſtance to their deſtruction. When this almoſt convulſive ſtimulus has abated, the ſubſtances thus heated with a naked fire, and in an open apparatus with the contact of the air, become ſoftened, or melted, ſwell, exhale an abundant vapour, or ſmoke, of a white, yellowiſh, or reddiſh colour, which diffuſes a fetid ſmell known to every one, and greatly differing from that perceived in the vegetable matters when treated in the ſame manner. Almoſt always an ardent and lively flame ſucceeds theſe firſt effects, and the reduction into coal or aſhes, more or leſs coloured, which terminates them, leſs ſpeedily and leſs eaſily than happens in the vegetables,

tables, indicates the presence of an oily substance, whatever the animal body may originally be which is treated in this manner.

4. When animal compounds are heated in a retort of luted glass or porcelain, to which is adapted a receiver, provided with a pneumato-chemical apparatus, we at first obtain a more or less abundant quantity of water, according to the liquid, soft, or viscous state of these compounds. This water soon comes over brown and turbid; it contains different ammoniacal salts; it is soon accompanied with carbonate of ammonia, which dissolves in it at first, and afterwards crystallizes upon the neck of the retort and the sides of the receiver. This second product is succeeded by oil, which becomes more coloured and consistant towards the end of the operation; whilst it passes no water is disengaged, or but very little. The oil is accompanied with carbonate of ammonia, which continues to be sublimed, and part of which is melted and dissolved by the very hot oily vapour. At the same time gases more or less abundant are developed, and collected in the bell-glasses, which terminate the apparatus: if we cause them to pass through lime water, or the metallic solutions, or the oxigenated muriatic acid, they precipitate the first in chalk, the second in coloured sulphurets, and they deposit drops of oil and coaly powders in the third. When the retort which is employed in this operation

operation is heated to ſuch a degree as to become ignited at the bottom, we no longer perceive any thing diſengaged, either in the aërial, liquid, or ſolid form; the white vapour which fills the apparatuſes of the receivers diminiſhes and is condenſed, even though the fire be very violent. The fire is then put out, and the veſſels are left to cool; they are afterwards unluted, and the products are examined after they have been ſeparated, either by their different place in the veſſels of the apparatus, or by pouring them into a funnel, where each aſſumes a poſition relative to its ſpecific gravity. Thus are obtained coloured water, concrete volatile ſalt, animal oil, gaſes and coal. Each of theſe products merits a particular examination.

5. The water, as I have already announced, varies in quantity according to the ſtate of the animal matter. It is, however, here ſuppoſed to proceed from a dry matter; for liquids are treated on the water-bath, and coagulated, or inſpiſſated before they are treated in the retort. This water was not contained intire in the animal matter, but a great part of it is formed, as I ſhall ſhow hereafter. Here we ſpeak only of its nature. Its colour, which is red, or yellow, or brown, its fetid ſmell, its acrid taſte, its turbid ſtate, prove ſufficiently that it is not pure water. When it is diſtilled with a double heat, or rectified, though carbonate of ammonia is frequently ſeparated from it, it generally

nerally passes more clear, and even transparent. When it is treated with lime, ammonia is disengaged; with the metallic solutions it renders them turbid and precipitates them; with the phosphoric acid, after the lime, and by submitting it to solution, a particular acid liquor is obtained, which Citizen Berthollet has discovered to be a new acid, and which he has termed the *zoonic acid*. In a word, we find in it an ammoniacal soap which colours it, and several ammoniacal salts which may exist to the number of five different species; namely, muriate of ammonia, and carbonate of ammonia, which we already know; zoonate of ammonia, prussiate of ammonia, and sebate of ammonia, which I shall describe elsewhere as particular animal salts. These five salts are not constantly found in the liquid product of the distillation of all the animal substances; but it always contains carbonate of ammonia and ammoniacal salt. There are some animal matters which, after fermentation, yield ammoniacal acetite, instead of carbonate, or at the same time with the latter. It is evident that this very complicated product, which was formerly called *volatile animal oil*, and was employed in medicine, was then very little known, and that its singular nature was not suspected.

6. The concrete and crystallized volatile salt, which is obtained of ammoniacal carbonate more or less soiled by empyreumatic oil. The ammonia is here a product of the fire; it does not

 exist

exiſt previous to its action in the greater number of animal ſubſtances. It has already been ſeen that its production has long been conſidered as the principal diſtinctive character of thoſe ſubſtances; but its ſource has only been known ſince the diſcovery of Citizen Berthollet, relative to the nature of this alkali, which is compoſed of five parts of azote, and one of hidrogen. It is evident that it is formed by the immediate union of theſe two principles, at the time when the greater part of the water already formed, leaves free hidrogen, and when a very high temperature augments the attraction of the oxigen for the carbon. Accordingly, there is produced at the ſame time carbonic acid, which ſaturates this volatile alkali. This ammoniacal carbonate is rectified by ſubliming it with a gentle fire. The formation of the three other acids frequently alſo accompanies that of the ammonia, which in part unites with them; and this formation is owing to the combination of three ſimple combuſtible baſes with oxigen, as I ſhall explain elſewhere. Formerly great virtues were attributed to this more or leſs oily carbonate of ammonia; it was believed that it carried off from each animal matter from which it was obtained, ſome principle which gave it particular characters: ſuch was that of the viper, of hartſhorn, &c. At preſent it is known that it is one and the ſame, from whatever matter it has been extracted. We ſhall ſee hereafter, that though all the animal

matters equally furnish this product, they greatly differ from each other with respect to the proportion in which they afford it. It is also to be remarked, that some of the immediate materials of plants, especially the extract, the tanin, the gluten, &c. and some entire plants, amongst which are to be distinguished the cruciferous, the papaveraceous plants, the fongusses, the nitrous plants in general, yield carbonate of ammonia in distillation, and that this property, which they owe to their containing azote amongst their principles, was the reason why they were called in the school of Rouelle by the not improper name of *animal plants*, though it was not known in this school from what source that product proceeded.

7. The oil obtained in the distillation of the animal matters was no more contained in these matters than the ammonia which is volatilized from them; it is equally a product of the action of caloric upon their principles. It is formed at the time when a large portion of the oxigen of these matters, absorbed by the hidrogen to form the water which passes over first, leaves in the residuum a greater proportion of hidrogen which approaches this residuum to the oily state. This oil differs from that which the vegetables, treated in the same manner, afford, by its abundance, its thick, concrete state, and its ammoniacal nature; it turns the blue vegetable colours green; it has a fetid and very tenacious smell. Dippel, a chemist of Berlin,

was the firſt who rectified this oil for medicinal uſe: it has therefore been called by his name. This rectification conſiſts in diſtilling it with a mild heat, not exceeding the temperature of boiling water, and which is ſtill better, from this liquid itſelf introduced into a retort with the oil, as Rouelle has recommended. The rectified animal oil is white, very liquid, very odorous, and very volatile; it is quickly turned yellow and brown by the contact of the air, and the light. Carbon which colours it, is ſeparated from it.

8. The gaſes which are diſengaged from animal matters treated in the retort, which Hales had conſidered to be air, and which induced him to aſſert that this principle was the cauſe of their ſolidity, becauſe at the moment when they eſcape, theſe matters generally loſe their coherence, are mixtures of carbonated hidrogen gas, frequently ſulphurated, and even phoſphorated at the ſame time, and carbonic acid gas. They are very fetid, very combuſtible, and they frequently burn with an oily flame: to theſe is owing the infected odour diffuſed by the animal matters which are burned in the air, or which are diſtilled in ill-cloſed veſſels, as well as when the veſſels in which their products have been received are unluted. When theſe gaſes are kept for a long time under water, it becomes turbid; there is frequently depoſited upon the ſides of the veſſel a carbonous and ſulphureous cruſt, of a blackiſh

brown

brown colour; frequently alſo, we perceive drops of a thick brown oil, precipitated and attached to the glaſs; which proves that theſe gaſes carry off a portion of this body in ſolution. If we make them paſs into lime water, they precipitate it in calcareous carbonate; in a nitric ſolution of lead, they form a blackiſh brown precipitate; when they paſs into oxigenated muriatic acid, carbon is ſeparated and precipitated in the liquor. They have been examined and analized by detonation with oxigen gas in Volta's eudiometer, after the carbonic acid had been ſeparated from them by a cauſtic alkaline ley. It was in this manner that Citizen Berthollet aſcertained their nature.

9. The coal which remains in the retort after the diſtillation of an animal matter, very rarely retains the primitive form of this matter; for it becomes ſoftened, fuſed, and ſwelled by the action of the fire. It is more denſe, more ſolid, and adheres more firmly to the glaſs than that of the vegetable ſubſtances; frequently it even forms one ſubſtance with the retort, ſo that its weight cannot be aſcertained, unleſs the veſſel has been weighed previous to the operation, and weighed again at the termination of the proceſs. Its proportion is in general leſs than that of the vegetable coals; it is rarely or hardly ever inflated or cavernous, at leaſt unleſs an albuminous or ſaponaceous liquid has been diſtilled; in the latter caſe alſo, we frequently find only a coally layer,

layer, which occupies more ſpace in the retort. Sometimes the animal coal is brilliant, of a metallic appearance, and it is then found very analogous to the carburet of iron. Its combuſtibility is in general very ſlight; it muſt be kept at a ſtrong red heat, and agitated for a long time in contact with the air, in order to reduce it into aſhes; it is not ſeen to burn ſenſibly, and become covered with a layer of aſhes, like that of the vegetables. The ſtrong fire neceſſary for its incineration, frequently changes the nature of its reſiduum and volatilizes a part of its ſalts. Soda and muriate of ſoda are diſengaged from it; the phoſphates which it contains are vitrified. Accordingly Citizen Berthollet, in order to analyſe the animal coals, has employed nitrate of pot-aſh, by cauſing them to detonate in veſſels proper for collecting the elaſtic fluid products, and the pulverulent reſidues. I have employed the ſuper-oxigenated muriate of pot-aſh for the ſame purpoſe. This character of incombuſtibility, which ſo eminently diſtinguiſhes the animal coals, proceeds from the little carbon which they contain, the denſity which it preſerves in them, its union with the phoſphates of ſoda and of lime, and the oxides of iron and manganeſe, which invelop and condenſe it.

10. All the effects of fire upon the animal matters, which I have juſt deſcribed, all the products which I have examined, prove that caloric, by changing the nature of theſe matters, and making a complicated analyſis of them,

them, combines their conſtituent principles in another order, and that finding them more numerous than thoſe of the vegetable ſubſtances, it gives riſe to a greater number of new compounds. Water is formed in them leſs abundantly, oil in larger quantity; ammonia, eſpecially in conſiderable quantity, excluſively belongs to them; the acids which unite with them, all announce, like the ammonia, an abundant ſource of azote. Leſs carbonic acid, and more hidrogen gas than in the products of vegetables, indicate a ſmaller proportion of carbon, and a larger of hidrogen in the animal ſubſtances. The ſulphur and the phoſphorus which modify their gaſes, announce the preſence of theſe two combuſtibles in theſe ſubſtances. This ſeries of the effects of fire, and of the products to which it gives riſe, proceeds, therefore, from the primitive complication of the animal compounds, from the multiplied action of their principles upon one another, and from the more numerous attractions which they reciprocally exert. None of theſe effects of caloric, which are very well adapted for elucidating the nature of theſe compounds, though they were formerly believed to be very obſcure and almoſt inexplicable, is at preſent attended with any real difficulty, and it is one of the fineſt reſults of the pneumatic chemiſtry, to have afforded a clear and eaſily intelligible explanation of them. It has been able to derive great advantage from what had long been only a ſource of errors and of obſtacles to its progreſs.

ARTICLE

Article III.

Of the Properties of Animal Matters treated by the Air.

1. THE properties which the animal matters prefent, when expofed to the contact of the air, and by the effect of this expofure itfelf, are lefs general and lefs conftant than thofe which are produced in them by the action of fire; they vary much more amongft themfelves, according to the differently modified nature of thefe matters, than the preceding. In general, thofe which are folid undergo very little alteration, or a very flow alteration by the contact of the air; the liquid animal fubftances are almoft exclufively and much more fenfibly changed by the impreffion of the air; and it is according to thefe changes that I fhall here announce the properties of thefe matters, referring them to a certain number of general heads.

2. I find fix different effects produced by the air upon animal fubftances, independant, indeed, of thofe which it can produce in the living animals; for the general characters of the fubftances which I examine are taken more efpecially in their dead ftate; the vital motion caufes them to vary, or renders them complicated, and we muft firft determine what takes

place

place in them without the vital principle which animates them, before we can treat of the phenomena which accompany their living state. These six effects refer 1, to the absorption of oxigen; 2, to the concretion which it produces in them; 3, to the colouration to which it gives rise; 4, to the slow combustion which it excites in them; 5, to the alteration which it experiences itself; 6, finally, to the decomposition which they suffer by the internal motion which it excites in them. I shall recapitulate each of these effects in succession.

3. Almost all the animal liquids have the property of absorbing the atmospherical oxigen gas; those which are viscid, gluey, or saponaceous, possess it in a pretty high degree. This is proved by leaving them exposed to the air in inverted jars, suffering them to elevate themselves in these vessels, and afterwards examining the residual gas by the endiometrical processes. We find that it contains much azote gas, and that it is sometimes even reduced to this gas in a pure state, when the exposure to the air has been long continued. The absorbed gas remains simply condensed, and particularly combined for some time: accordingly, the oxigenated liquids swell considerably in vacuo or by the action of heat. Gradually the oxigen becomes more solidly fixed, combines intimately with them, and changes their nature by oxiding them more than they were before.

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4. The concretion of the animal liquids consequent upon the abſorption of oxigen is eaſy to be obſerved, and leaves no doubt of the exiſtence and reality of this ſecond effect in the white of egg, the ſerum of the blood, the water of hydropic patients, &c. expoſed to the air. We ſee flakes formed in the liquids, remain ſuſpended in them, and become precipitated. By agitating the liquids in the air, they acquire ſuch a diſpoſition to concretion, that a part becomes ſolid. In this manner are formed the factitious membranes known at Cos, more than a thouſand years ago, and deſcribed by Hippocrates. The aërated water produces the ſame effect by its mixture and agitation with theſe liquors. White of egg expoſed to the air, or eggs that have been kept for ſome time, boil and harden much more eaſily than very freſh eggs. This phenomenon is connected with the formation and the regeneration of the epidermis; it explains the *plaſtic powers* of the ancients; it ſubſtitutes a ſimple phyſical fact inſtead of an occult quality; it preſents itſelf in the mechaniſm of nutrition.

5. A thouſand phenomena prove the colouration produced in the animal ſubſtances by the contact of the air and by the ſlow abſorption of oxigen. Even the ſolids are not exempted from this conſtant effect. Bones and ivory become ellow, the ſkin turns brown and black in the r; the blood reddens in it and aſſumes the bril-

brilliant purple colour which characterizes it, whilst that part of it which is deprived of the contact of the air remains of a dark, and almost black colour. The white albuminous and gelatinous liquids become yellow; fats acquire a citron or orange-colour; wax and spermaceti become yellow; the colours of the kermes, cochineal, several worms, and some mollusca acquire their greatest lustre by the contact of the air; the bile, the urine, and the perspiration acquire a more intense colour in the atmosphere; the white discharges from the nose, the lungs, the urethra, from ulcers, become yellow or green; all the marine animal products become darker-coloured and browner when they are taken out of the water and placed in the air; putrefaction is accompanied, and its periods are marked by many different tinges.

6. The first effects which have just been enunciated, whilst they indicate a remarkable attraction between the animal matters and oxigen, show pretty clearly that they represent a kind of slow combustion, which causes them to pass into the state of oxides, and which, in some cases, though indeed rarely, gives them even the character of acids: it is in this manner that the acetous acid is produced in several substances exposed to the air, especially in milk and urine. The disposition to coagulation by the fire, or to spontaneous concrescibility, corresponds with the solid and concrete form which the

the oils assume when they are exposed to it, and represents a real oxidation which has its limits and its termination, at the point when the animal matter which experiences it is saturated, and can no more absorb a larger proportion of oxigen. This analogy with the concrescibility of the vegetable oils authorizes us to consider the animal compounds as approaching to the oily character, or very much disposed to assume it.

7. The four phenomena that have been enunciated do not take place without the air itself undergoing a change, a more or less considerable alteration. When an animal matter has been for some time exposed to it, we find this air less charged with oxigen, more saturated with water, containing much carbonic acid, and infected with a disagreeable smell. These four changes correspond with four kinds of effects produced by the animal substances; they immediately absorb a portion of the atmospherical oxigen; their hidrogen burns rapidly and forms water; their carbon destroys also a portion of the oxigen gas, which dissolves and acidifies it; finally, a portion of the animal matter itself, already much altered and corrupted, or at least the sulphurated, phosphorated and carbonated hidrogen gases which are disengaged from it, give the air a very marked character of fetidity. Thus, we conceive the cause of the infection and of the noxious properties which the air acquires in the chambers

of

of sick persons, in hospitals too confined, &c. and perhaps even the manner in which certain fevers, &c. are communicated.

8. In proportion as animal matters absorb the atmospherical oxigen, they become disposed to concrete, become coloured, experience at first a slow real combustion, and at the same time pour into the air different principles which change its nature, and thus these substances sensibly proceed towards that spontaneous decomposition which tends to destroy them, or to reduce them to more simple, namely, binary compounds. We see them from day to day vary in their consistence, their colour, and their smell; fetid effluvia and gases are disengaged from them; their volume is changed, their principles exhale; there is formed in them water, carbonic acid, ammonia, or nitric acid; in a word, they suffer an intestine motion which destroys them, separates a portion of them in the gaseous form, and leaves a part of their fixed residuum in the state of mould. Putrefaction, one of the most marked characters of the animal compounds, one of the phenomena that most deserve to be studied with attention, will be described in one of the subsequent articles. I have indicated it here only in order to exhibit the series of the effects of air upon these substances; for the contact of air favours and accelerates it.

9. If we compare the six effects here indicated, we find as the result, a great alterability in the animal

tion can load him. There are some animal matters which are always found diluted with water, liquefied by it, and owe to it their state, as well as that mobility which permits their transportation into different parts of the bodies of animals. Most of the animal liquids are easily miscible with water; and if we except the solids, all the animal parts are soluble in this liquid.

3. When we cause hot and boiling water to act upon animal matters, there are several which, though insoluble in this liquid when cold, dissolve in it easily and quickly by means of that activity which the caloric communicates to it. Such are most of the white membranous textures which melt in boiling water, and afterwards form jellies with it by cooling, and glues by evaporation; it is on this account that these textures are called *gelatinous* in chemistry. When we give to the water, by compression in Papin's digester which prevents its evaporation, a much higher temperature than that of boiling water, we at last soften even the bones, and cause them to assume the gelatinous state. The corneous and cartilaginous textures pass into this state still more easily and quickly.

4. There are some animal liquids, analogous to the white of egg, and on that account called *albuminous*, which suffer by the action of hot water below 48 degrees of temperature, a coagulation, an induration, and an opacity with which every

every one is acquainted. This property, which is oppofite to the gelatinous folubility, announces, in the fubftances which are fufceptible of it, a very different nature, and it has defervedly occupied much of the attention of chemifts and phyficians. Whilft the latter have defcribed it as a particular and living power, which they have called *plaftic*, the former have difcovered that it depends upon the oxigenated ftate of the animal liquids, or at leaft that it is confequent to this ftate; that it is owing, as I have fhown in the preceding article, to the intimate combination, the fixation of this principle.

5. That effect of hot water upon the infoluble animal folids which is the moft generally known, is the boiling of meat. Chemifts, however, have not yet accurately determined the mechanifm of this effect. It is known that there is produced by it, in the boiled fubftances, a diminution of their tenacity, a change of texture, of colour, of tafte and fmell, which renders them agreeable to the organ of tafte and eafy of digeftion. It appears that the coction or boiling confifts in a change of proportion and of ftate in the animal compofition, the fufion of the gelatine, the coagulation of the albumen, and a kind of maceration of the fibrous organization, which renders them eafy to be bruifed by the teeth, and reduced into a foft and ductile pafte by maftication. This property is very different from the coction which the vegetable

substances undergo, and the change which the latter suffer is very distinct and less sensible to every one. Many vegetable matters may be used as food in their crude state, but the civilized part of the human species cannot eat raw animal substances.

6. Long maceration in water changes also the texture and the nature of animal substances in a manner so different from the effect it produces upon the vegetables, that we must thence derive a very decisive character for establishing a well marked difference between those two classes of organic compounds. Almost all the animal matters, when immersed in water, become converted into a fatty substance, analogous to spermaceti, which I have already indicated by the name of *adipocire*. Ammonia at the same time formed, which is dissolved, and carbonic acid which exhales. It is known that in like circumstances the vegetables blacken and become carbonated. This phenomenon, in the animal matters, depends upon their putrescibility; and it is sufficient here to mention it, since its cause and its results will be treated in a more explicit manner in the article concerning putrefaction.

7. It is evident from these effects of water upon the animal compounds, that the general cause which determines their differences from that which the vegetable matter suffer, depends upon the more complicated composition of those bodies. It is always the smaller propor-

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tion of carbon and of oxigen, and the larger of hidrogen and azote, which give rise to the changes that have been mentioned, and the phenomena that have been described. These changes are more numerous, more varied, and more considerable, because they take place in substances, the constituent principles of which are more multiplied, and obey a greater number of attractions at the same time; it is because they take place in substances, the equilibrium of whose composition, is much more easily disturbed than that which exists in the less complicated vegetable compounds.

In this simple explanation we perceive a coincidence which always obtains, between the consequences of the action of water and the effects of the other agents that have been studied in the preceding articles. This coincidence will also be perceived in all the subsequent articles.

Article V.

Of the Action of the Acids upon Animal Substances, considered as a Character of these Substances.

1. THE manner in which the acids act upon the animal substances, furnishes chemists at present also with a means of characterising these compounds and appreciating their nature.

The ſcience has made great progreſs with reſpect to the knowledge of this action ſince the eſtabliſhment of the pneumatic doctrine; and in particular it owes much to the labours of the French chemiſts, eſpecially thoſe of Citizens Berthollet, Vauquelin, and myſelf. There are two principal conſiderations to be preſented relative to the action of the acids; the one belongs to all theſe bodies, and is general amongſt them; the other is relative to each of the acids in particular, and differs according to their peculiar nature. I ſhall follow this two-fold manner of conſidering them.

2. All the ſlightly concentrated acids preſerve animal matters and guard them againſt putrefaction; accordingly, they have always been conſidered as powerful antiſeptics, and they have been placed at the head of theſe medicines. All of them have alſo the property of coagulating and thickening the albuminous liquids, of rapidly diſſolving the gelatinous and membranous organs, of preſerving the fluidity of the liquids of the ſame nature, and of preventing them from concreting by refrigeration, as they are accuſtomed to do when alone; they alſo ſoften and diſſolve, with the aid of heat, the fibrous organs, or thoſe which contain in their texture the matter which is called *fibrine.* This ſolution frequently aſſumes the tremulous and gelatinous form. They diſſolve and in part decompoſe the ſolid animal ſubſtance, and change its phoſphate of lime into acidulous

lous falt. Laftly, all the acids, when left for a long time in contact with moft of the foft membranous, or fibrous animal compounds, alter them in the courfe of time, convert a part of them into ammonia, and are afterwards found more or lefs faturated with this alkali.

3. The particular action of each acid is determined by its own peculiar nature; it is in general more powerful and more capable of decompofing animal matters, in proportion as the acid itfelf is more feeble in its intimate compofition, and as its radical adheres lefs ftrongly with the oxigen. There are fome alfo which, without being fo eafily decompofed, act upon thefe matters merely by their acid power. This action varies befides according to the ftate of concentration of each of thefe acids,—according to the quantity of acid placed in contact with the animal matters,—according to the more or lefs folid or foft ftate of thefe matters; and laftly, according to the temperature by means of which we caufe them to act reciprocally upon one another. Amongft the different acids which exert an influence more or lefs evident, and confiderably different upon the animal compounds, we muft particularly diftinguifh the fulphuric, the nitric, the muriatic, and the oxigenated muriatic acids: they comprehend all that need be confidered as to this particular action; for the others, and efpecially the phofphoric, the acetous, the nitric, the tartarous, and the oxalic, fingularly refemble the muriatic.

muriatic. It must not be forgotten that the four first, taken in a diluted state, exert only the general actions which have been indicated above.

4. There was formerly observed in the manner in which the sulphuric acid acts upon animal matters, the softening which they expeience, with the more or less intense colouration they undergo: and it was believed that this effect announced a kind of semi-combustion beyond which nothing was apprehended: it was compared with the action of fire. Citizen Vauquelin and myself, on examining the phenomena of this action, discovered that the ancient notion was erroneous, and that there takes place between these substances a series of attractions which change their nature in a very different manner than had been imagined. When we immerse an animal matter, flesh, for example, white of egg, or coagulated blood, into concentrated sulphuric acid, and leave these two bodies to act spontaneously, we first see the animal matter assume successively the fawn, the red, the brown, and the black colours, become softened, divided, dissolved, and form a kind of paste. The mixture becomes heated; nothing is disengaged; and on examining it after the action is terminated, we find sulphuric acid weakened with water, which it did not contain at first; the animal matter is reduced to coal, and fatty particles detach themselves from it. If we analyze the sulphuric acid, we find it in part

part ſaturated with ammonia and ſoda. We therefore find that it has decompoſed the animal ſubſtance, that it has ſeparated from it hidrogen and oxigen, which have united to form the water neceſſary for its ſaturation; that another portion has compoſed ammonia, a third has paſſed into the ſtate of fat, and a fourth into that of a coally reſiduum.

5. When we afterwards dilute the acid with a ſufficient quantity of water, then filtrate it in order to ſeparate the fat and coally matter, and analyze the filtrated liquor, we find in it ſulphate of ammonia, ſulphate of ſoda, ſulphate of lime, and a more or leſs conſiderable quantity of acetous acid, which may be obtained by diſtillation. It is therefore proved, that the ſulphuric acid has decompoſed the ſalts of ſoda and of lime contained in the animal matter, that it has converted it into ammonia, acetous acid, water, fatty matter, and coal. We here find an analogy with its effect upon the vegetable ſubſtances deſcribed in the preceding ſection; with very remarkable differences, the formation of ammonia and of fat, and the production of the ſulphate of ſoda and of lime. It would be ſuperfluous to explain in detail the cauſes of theſe differences, ſince what has hitherto been ſaid ſhows ſufficiently that they ariſe from the azote of the animal matters, the greater proportion of their hidrogen, and the preſence of the phoſphoric ſalts.

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6. If instead of leaving the sulphuric acid to act spontaneously upon the animal matters, we assist its action by heat, its effect becomes more rapid and more effectual. It is no longer, as in the former case, merely the tendency of the acid to become saturated with water that effects the decomposition of these substances, and which brings into play the complicated attractions proper for changing their nature. The principles of the sulphuric acid themselves tend to separate; the attraction of the hidrogen and of the carbon of the animal matters for the oxigen of the acid, is augmented by the addition of caloric; a more profound alteration takes place in their nature and composition. There is no longer any oily substance formed, with water simply constituted for the saturation of the acid which no longer retains its character; the animal matter approaches much more to the ultimate term of its decomposition. Accordingly we see an effervescence arise, which is prolonged; carbonic acid gas, sulphureous acid gas, sulphurated and carbonated hidrogen gas disengaged. Much water passes in distillation; for this experiment ought to be made in a distilling apparatus; the acetous acid is destroyed; we obtain sulphate of ammonia, and the quantity of coally residuum is less than in the first case.

7. The nitric acid comports itself in a very different manner with the animal matters, because it is much less powerful and permanent, as

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an acid, than the ſulphuric, and eſpecially becauſe it is infinitely more decompoſable and much more oxigenated. It was formerly remarked that it gives to thoſe ſubſtances a lemon-yellow colour, and that it does not reduce them to coal like the preceding. Its mode of acting upon the vegetables, which has been explained in detail, in one of the articles of the ſection relative to them, will here ſerve me to account for that which it exerts upon the animal matters; we ſhall obſerve a more complicated operation; we ſhall remark in it important reſults which the pneumatic doctrine has enabled us to deduce from it. When Bergman made known the formation of the acid of ſugar, or the oxalic, by the nitric acid, Citizen Berthollet found, in 1777, that ſilk, wool, the muſcles, the ſkin, the tendons, and the hair, afforded more of it than ſugar, and that this quantity ſometimes even amounted to more than half of their weight, whereas ſcarcely a fourth could be obtained from the vegetable matters. He diſcovered at the ſame time, and, as we ſee, at a period already remote (now nearly twenty-two years ago), that there was ſeparated an oil, during the formation of the oxalic acid, from the animal matters, and that this oil yielded ammonia in diſtillation. This was already a ſtriking difference obſerved in the action of the nitric acid upon theſe matters.

8. Eight years after this firſt diſcovery, the ſame chemiſt made another ſtill much more important

portant discovery, relative to the action of the nitric acid upon the animal matters. Having seen that they yielded by this acid, when rather weak, and almost without the addition of heat, a large quantity of azotic gas, he remarked that this property accorded with that of yielding ammonia; that when they had lost their azote they seemed to make a retrograde step toward the vegetable state; that all the substances which furnish ammonia exhale also azotic gas by the action of the nitric acid; that in this action there was disengaged, after this gas, carbonic gas and nitrous gas; that the oxalic acid was then formed, and the fatty matter separated; that when the yellow liquor was evaporated in order to obtain the oxalic acid, acid phosphate of lime remained in the mother water: thus he established a very essential difference between the vegetable and the animal matters. I examined, a short time after this discovery, all the circumstances of the disengagement of azote from animal matters by the nitric acid; I have proved that this acid was not decomposed as long as that disengagement continued, and that it thus belonged to the animal matter; that gelatinous matters afforded less of it than the albuminous, and these less than the fibrous; that the azotic gas thus obtained, had a particular faint odour, analogous to that of animal matters when they begin to become tainted, to that of muriate of ammonia sublimed, of ammonia decomposed by the oxigenated

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muriatic acid, &c.; and that its proportion exactly followed that of the ammonia afforded by each animal matter; that when it had been ſeparated from an animal compound, this was no longer putreſcible as before; that this gas was very deleterious, that it appeared to have an influence upon the production of putrid diſeaſes in men expoſed to its action. Since my firſt aſſertion, ſome have attempted to make a point of medical theory of this object, and its reſult has been deſignated by the name of *ſepton gas*, given to the azotic gas.

9. In 1790, another diſcovery preſented itſelf to me in the courſe of my experiments relative to the action of the nitric acid upon the animal ſubſtances; namely, the formation of the Pruſſic acid, and its diſengagement in vapour, eaſily diſtinguiſhable by its ſtrong ſmell of bitter almonds: as it will be treated of more in detail in one of the ſubſequent articles, I ſpeak of it here, only in order to complete the enumeration of the principal effects of this acid. We ſee that thoſe effects conſiſt in a yellow or red colouration, in the diſengagement of azote in the ſtate of gas, in the formation of the Pruſſic acid, of the oxalic acid, of the carbonic acid, and of a fatty matter. The difference of this action from that of the ſulphuric acid, conſiſt in the ſeparation of azote, the formation of a thicker oil, of leſs water, the abſence of ammonia, the non-precipitation of carbon, the formation of the oxalic acid; it

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depends evidently upon the greater ſolubility of the animal matter in this acid, its larger quantity of oxigen, which ſeizing the principles of this matter, inſulates and burns its carbon, employs its hidrogen with a portion of this carbon itſelf and of the oxigen in the formation of the kind of fat, &c. Theſe united effects are ſtill more numerous and more difficult to be well explained than thoſe produced by the ſulphuric acid, as there are more attractions acting at the ſame time; they are nevertheleſs very well adapted for making us acquainted with the nature of the animal ſubſtances and confirming what has already been enunciated reſpecting them.

10. The muriatic acid preſents nothing particular in its action upon the animal ſubſtances, neither do the phoſphoric or the vegetable acids; it is only a little more powerful than the latter. They all diſſolve the fibrous and muſcular part, reduce it into a kind of jelly; and at laſt they decompoſe and convert a part into ammonia, which ſaturates them. They coagulate the albuminous liquids, ſoften, and in part decompoſe the bones, as well as the cartilages; they alſo diſſolve the membraneous textures. It is believed that this effect takes place during life, by the abuſe of the vegetable acids, of the acetous and of the nitric acid, and that it is on this account that perſons who take them in abundance grow lean, and loſe even a portion of the bulk or of the thickneſs of their

their mufcles. With refpect to the oxigenated muriatic acid, it acts with a far fuperior energy upon thefe fubftances. At the moment of its contact with thofe animal liquids, it thickens, coagulates and condenfes them into flakes, into mucous fragments, and thus confirms what I have faid of the coagulation of this humour by the combination or the fixation of oxigen. It hardens the folids, makes them fhrink and contract, weakens their colour without deftroying it, and even brightens that of feveral of them. We fhall fee hereafter that its powerful action upon the humours and the organs of living animals, is calculated to throw fome light, at a future period, upon their functions and phyfiology.

Article VI.

Of the Properties of Animal Matters derived from their Alterability by the Alkalis.

1. THE violent action of the cauftic alkalis upon animal fubftances has long fince been obferved by chemifts; but not knowing then either the pure ftate of the alkalis, or the intimate nature of the organic compounds, they were neither able to explain this action, nor to avail themfelves of it for the purpofe of afcertaining the compofition of thefe matters. It was a fact which they had obferved, without being

being able to deduce from it inferences uſeful for the advancement of the ſcience, and they contented themſelves with making ſome applications of advantage to ſeveral of the proceſſes of the arts, ſuch as the employment of fixed alkalis rendered cauſtic by means of lime, for the purpoſe of opening iſſues, extirpating indolent and ſteatomatous tumours, clearing the fat out of wool, &c. It is only ſince the riſe of the pneumatic doctrine that the action of the alkaline cauſtics upon animal matters has begun to be known and employed for the purpoſe of determining their nature.

2. It was firſt remarked that theſe re-agents acted in a much more powerful manner upon animal than upon the vegetable ſubſtances, and that whilſt they diſſolved the latter but ſlowly and with difficulty, they ſoftened and diſſolved the former with rapidity: it was alſo perceived that all animal textures treated by cauſtic alkaline leys loſt their ſtrength and their weight, whilſt thoſe of vegetable filaments were but very little altered by them. To this action is to be attributed the kind of greaſy and unctuous feel which we perceive when we rub the cauſtic leys between the fingers; a phenomenon which cauſed the name of *oil of tartar* to be given to the concentrated ſolution of pot-aſh. This ſolubility of the animal matters takes place even by the ſolid fixed alkalis, becauſe they find a ſufficiency of water in theſe matters to

to become first softened and dissolved, whence they are afterwards enabled to act as solvents.

3. In 1782, Citizen Berthollet published a Memoir upon this action of the alkalis: he represented it as the effect of a simple combination, into which the animal matters entered intire: he remarked that wool, silk, flesh, boiled with a concentrated ley of pot-ash, were dissolved in it, deprived it of its causticity, gave it a bitter taste, and a red colour, but did not take carbonic acid from it, as Macbride had believed; that this solution was precipitated by the acids and the metallic salts; that in the latter precipitation, the deposit, composed of animal matter and oxide approaching to the metallic state, was unalterable and not imprutrescible; that it did not precipitate the super-oxigenated muriate of mercury, whilst a solution of sugar and of starch in the same alkali did not destroy its causticity but decomposed this metallic salt; that the animal matter thus saturated the alkali.

4. A phenomenon observed by the same chemist induced me to adopt an opinion different from his; it led me to make a series of experiments which furnished me with another theory, by showing me that something different from a simple solution took place. Citizen Berthollet had remarked that the solution of an animal matter by caustic alkali exhaled a disagreeable putrid smell. I soon found that in fact every substance of this nature disengaged a remarkable quantity of ammonia at the moment when it

was treated by a ſtrong alkaline ley; that at the ſame time caloric was diſengaged; that the ſame circumſtances took place, though with leſs energy, with lime, ſtrontian, and barites. As a freſh animal matter does not contain ammonia ready formed, I concluded that it was formed from it by the action of the alkalis, that after this the matter being once diſſolved was no longer the ſame as before its ſolution, but that its nature was changed. In the preparation of the animal ſoap which is manufactured according to the recommendation and the advice of Citizen Chaptal, by boiling ſhreds of woollen ſtuffs in a ſtrong ley of pot-aſh, 'till it diſſolves no more of them, this liquid and coloured ſoap, uſeful in the manufactories of flannels, of cloths, and of blankets, retains and gives to the ſtuffs a diſagreeable ſmell which proceeds from this ammonia that is formed, and is diſſipated in the air by much waſhing.

5. It is eaſy to conceive that in proportion as ammonia is formed, the animal matter loſing five times as much azote as hidrogen, muſt contain in its portion united with the alkali much more hidrogen than before, and that having thus contracted an oily character its alkaline combination is a real ſoap; accordingly, all the properties deſcribed by Citizen Berthollet in this ſolution are ſo many characters of a ſaponaceous compound. The acids decompoſe it and ſeparate from it a concrete brown oil;

oil; the metallic folutions form in it infoluble precipitates of foaps; and the fame is the cafe with the earthy falts. Citizen Chaptal has propofed it to anfwer the purpofes of a real foap in the woollen manufactures. It is evident tnat there is no proof wanting to my opinion.

6. The red or brown, more or lefs deep colour which animal fubftances affume when they are diffolved in the cauftic ley of fixed alkalis, indicates alfo another change of thefe fubftances. It is eafily conceived that when azote and hidrogen is feparated from them to form the ammonia which is difengaged, a portion of infulated carbon muft be precipitated, and that the oil then formed muft approach to the nature of thofe which are called empyreumatic. Petit obferved, in 1733, in the Memoirs of the Academy of Sciences, that a piece of lapis caufticus furrounded with fat and fkin, rendered thefe parts reddifh by remaining in them for fome hours. Poulletier de la Salle has defcribed, in his Commentary upon the Pharmacopeia of London, experiments made upon the application of the lapis caufticus to the fkin of a dead body, in which he obtained the fame refult. This agent, employed with the fame care and the fame apparatus upon the living fubject, produced an efchar, an excavation, with a margin of a livid-red colour, owing to its colouring action upon the fubcutaneous fat.

7. This action of the alkalis, which at prefent is well afcertained, explains their ufe as

caustics for removing malignant ulcers, indolent humors; it is evident how their employment as solvents for the diseases which require this kind of remedies, may become dangerous if abused; how the alkaline leys alter and weaken all the animal textures which are impregnated with them, or left to remain in them, and especially if heated with these liquors; as is frequently practised with wool, silk, hair, feathers, &c.

Article VII.

Of the Action of the Saline Substances, the Oxides and the Metallic Salts upon Animal Substances, considered as Character of these Substances.

1. I COMBINE in a single article the action of three kinds of substances upon animal matters, because it is either weak or difficult to be determined, or not yet appreciated with accuracy. There are few facts to be described, and few results to be deduced from the action of these bodies: it was, therefore, necessary that I should consider them together, not to separate them, but associate them in one consideration.

2. The preservative property which the salts show with respect to all the organic substances in general is well known, and a number of arts

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and proceſſes eſpecially prove the exiſtence of this property with reſpect to the animal matters. Alum hardens ſkins and contracts their texture, which it renders more durable; its ſolution is frequently employed in order to preſerve, againſt every kind of alteration, the organs or the parts of animals in anatomical collections. The muriate of ſoda produces a ſimilar effect, which preſerves meat ſo well, that it is employed in order to prevent its ſpoiling and to adapt it for nouriſhment. The ſame proceſs is employed for butter and cheeſe. Pringle imagined that a ſmall doſe of ſalt accelerated their putrefaction, whilſt a large one was antiſeptic: this opinion has been found to be an error, and that a ſmall quantity of ſalt ſuffers the animal matters to putrefy, only becauſe it does not abſorb the whole of their humidity.

3. The earthy ſalts, whilſt they preſent the property of the preceding, exhibit another character in their active energy upon animal matters; they decompoſe their ſoluble phoſphates, namely, thoſe of ſoda and ammonia, which are almoſt conſtantly contained in the liquors of animals: hence it comes that when we pour ſolutions of nitrates and muriates of lime, magneſia, or ſtrontian, into the ſerum, whey, urine, the water of hydropic caſes, or water in which fleſh has been boiled, &c. a more or leſs abundant precipitate is produced, which is always phoſphate of lime. The ſoda which exiſts inſulated, or in the ſaponaceous ſtate in ſeveral of

these liquors and in the bile, alſo decompoſes these ſalts and precipitates their earthy baſes; ſo that this precipitate is frequently two-fold and conſiſts of earthy phoſphates and earth. In the caſe of the ſaponaceous animal liquors, the precipitate which is formed is an inſoluble earthy ſoap. The aluminous ſalts, whilſt they produce the ſame effect upon the coloured liquors, frequently deprive them of their colour, with the matter of which alumine has a ſtrong affinity.

4. It is evident from this expoſition that the ſaline matters have almoſt always a very complicated effect upon the liquid animal ſubſtances, a part of the ſalts of which they decompoſe, becoming decompoſed themſelves, eſpecially when they are of an earthy nature, and that they preſerve theſe matters when ſolid, and condenſe their texture. We muſt, therefore, confine ourſelves to theſe effects the generality which it is here neceſſary to preſent; we ſhall hereafter have occaſion to give an account of ſome other actions exerted by the ſalts upon ſeveral animal ſubſtances in particular, to ſhow that theſe actions depend upon the ſpecial nature of theſe ſubſtances, and that they ought to be conſidered as very proper for characteriſing them. It can ſcarcely be doubted that many ſalts with an alkaline baſe, which are not found in the animal compounds, produce in theſe compounds phenomena of decompoſition, or of triple and perquadruple union, which have not yet been

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determined. Much ſtill remains to be done for the Science in all theſe reſpects.

5. Thoſe metals which are the moſt eaſily oxided undergo this kind of alteration, when they are kept immerſed in ſeveral animal liquids. Iron, zinc, lead, and copper belong eſpecially to this order; their oxidation is more particularly ſpeedy and more marked in the albuminous liquors. This ſlow combuſtion is frequently ſucceeded by a real phoſphatization, by the union of the metallic oxides with the phoſphoric acid of the animal matters. Every one knows how eaſily ſilver becomes coloured and blackened by the contact of theſe matters, and even of the vapours which exhale from them. The ſulphurated hidrogen gas with which they are frequently charged is the ſource of this alteration; the ſulphur which abandons it, unites in the courſe of time with this metal, and it was the cauſe of the ſulphuret of ſilver formed by plates of this metal, which had remained for a long time in a privy at Compeigne, and were examined in 1765 by Macquer. Even the metals that are the leaſt eaſy to be oxidated, nevertheleſs aſſume this ſtate by trituration with thoſe animal liquors which quickly abſorb this principle. It is in this manner that mercury, gold and ſilver, triturated with ſaliva and fat, are converted in a longer or ſhorter time into real oxides when they have the contact of the air.

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6. The highly oxided metallic oxides, on the contrary, yield a more or leſs conſiderable portion of their oxigen to the animal matters with which they are placed in contact. It is in this manner that thoſe of mercury and of ſilver thicken and coagulate the albumen: ſome of thoſe which adhere the leaſt with it, and ſuffer it to be taken from them with more or leſs facility, even burn the animal compounds. Acknowledged as cauſtics, when they are applied to theſe compounds in the living ſtate, they may ſerve for making their analyſis when they are deprived of life. The animal matters are reduced into coal by the action of theſe oxides; whilſt it takes place water is formed, ſometimes ammonia, and in other circumſtances, nitric acid. It is on this account that the red oxide of iron, mixed with the animal ſubſtances employed in the artificial nitre-beds, contributes to the formationof this acid.

7. The ſolutions of the metals in the acids, act by both their component parts upon the animal liquors; there is not one of them that is not decompoſed, and the oxide of which is not ſeparated and approached to the metallic ſtate, by remaining in this liquor. Thoſe of the white metals, and eſpecially of mercury, and lead, and of ſilver, are precipitated at the very moment of their mixture with theſe liquors. This precipitate is formed either by the muriatic acid, or by the phoſphoric acid, which m part of the elements of theſe matters; the

ſoda

ſoda which they contain, alſo contributes to it; the albumen, which frequently conſtitutes a portion of them, by taking oxigen from the oxides of the ſolutions alſo produces their ſeparation from the acid: ſometimes even the ſulphurated hidrogen diſſolved in the animal liquids, enters for ſomething into the precipitation; ſo that the precipitates obtained in theſe operations may be compoſed of five different matters; namely, of a phoſphate, a muriate, a ſimple metallic oxide, and the ſame oxide albuminated and ſulphurated: a delicate analyſis made ſlowly by means of different acids, may exhibit each of theſe metallic precipitates, and even give the proportions.

8. The action of the metals and of the metallic oxides and ſolutions upon the animal ſolids, has not yet been examined with ſufficient accuracy for it to be poſſible to deſcribe it with exactneſs. It is known that theſe ſolids are preſerved by theſe ſolutions; that they become coloured, condenſed, contracted, and hardened; that they abſorb a portion of the metallic ſalt; that they decompoſe another and ſeparate from it the oxide which they approach to the metallic ſtate; that they at the ſame time ſuffer an alteration more or leſs conſiderable, according to the differently concentrated ſtate of the ſolution, and that in the frequently dark colour which they acquire, their carbon is inſulated, and their hidrogen burned. The moſt acrid and moſt cauſtic ſolutions burn and entirely deſtroy the texture of the animal

ſolids,

ſolids, by reducing them to a complete coally ſtate: it is for this purpoſe that they are employed in ſurgery.

Article VIII.

Of the Action of Vegetable Matters upon the Animal Subſtances, conſidered as Generic Characters of the latter.

1. THE entire vegetables, or the different immediate materials of vegetables, have not nearly ſo powerful an action upon the animal ſubſtances as that which they exert upon moſt of the preceeding ſubſtances; the effect which they produce upon them is frequently almoſt inſenſible. It is not obſerved, that they tend to diſorganize them, to decompoſe them, or to deſtroy the equilibrium which exiſts between their conſtituent principles; we conſequently find that they cannot be uſed for analyzing them. This action, however, is not a nullity; though it is feeble, it does not the leſs merit to be examined with attention, and deſcribed with care: we find in it phenomena which may add to the chemical characters of the animal ſubſtances, and contribute to the underſtanding of their nature.

2. Formerly we judged by the taſte of plants of their medicinal virtues, which ſome phyſicians had attributed to their chemical properties; but the erroneous notions which they had formed of the analogies of theſe two kinds of properties

perties are now banifhed by a found theory; and they no longer form a part of the fcience. It was thought that the juices of the vegetables mixed with the animal liquors ought alfo to fhow, in their fenfible action upon thefe liquids, the nature of their action in difeafes; fome were folvent or attenuant, others infpiffant and incraffant, fome anti-putrefcent, others aftringent and condenfing, others again feptic. It has been afcertained that thefe experiments were not only mere chimeras as to the theraputic theory, but alfo real errors with refpect to the chemical effects, which are ftill too much complicated, even at the prefent day, when the fcience is fo much farther advanced, to be capable of being well determined.

3. We may with greater facility appreciate the immediate, though feeble effects, produced by the immediate materials of plants, when fufficiently pure and infulated, upon the animal matters. The mucilages diffolve in their liquids, and frequently precipitate from them fuch materials as are lefs foluble than thofe which they contain. Sugar, whilft it produces this firft effect, acts befides as a preferver: fometimes by its folution it favours the alterability and fermentability of which they are fufceptible. It has already been feen that the vegetable acids coagulate the albumen, diffolve the fibrin and the gelatin, and prevent or retard their alterations.

4. All the inflammable oily bodies, all the materials of vegetables in which hidrogen appears

pears to be the ſuperabundant principle, act in an uniform manner upon the animal ſubſtances. When covered with fixed oil, they keep, and frequently ſuffer themſelves to be penetrated by it, like the ſkins which thus acquire pliability; the animal mucilages, the albumen, and the gelatin, render it miſcible with water by agitation, and ſuſpend it in emulſion; oil diſſolves the fats with the aid of heat.

The volatile oils, the balſams, the reſins, camphor, preſerve the animal ſubſtances from putrefaction: on this account they were employed by the nations of antiquity for the purpoſe of preſerving dead bodies in embalming.

So ſtrong and ſo marked an attraction is obſerved between the vegetable colouring matters and the animal textures; and this is ſo well demonſtrated by the ſolidity of the dyes applied to wool, ſilk, &c., that in order to make vegetable threads approach to the ſame ſolidity, they are ſucceſsfully impregnated with fat or animal oil, which diſpoſes the colouring matter to adhere to them.

The ligneous matter itſelf, however inert it may appear, is not entirely void of action upon the animal matters: when reduced into powder and thrown upon their ſurface, it dries it, abſorbs their moiſture, hardens them and preſerves them from alteration.

5. The different vegetable materials hitherto indicated are almoſt inert in compariſon with three other vegetable ſubſtances, the energy of which

which upon the animal compounds is infinitely ſtronger: theſe are the tannin, the gallin, and alcohol; each of them deſerves to be examined ſeparately. I have already upon a former occaſion ſpoken of the nature and general property of tannin; and I muſt hereafter treat with ſome detail of the cutaneous texture; it will, therefore, be uſeful here only to ſtate the general impreſſion which the animal matters experience from this ſubſtance. Tannin diſſolved in water precipitates the albumen and gelatin from their natural ſolutions or from the animal liquids which contain them. The precipitate, eſpecially that of the gelatin or glue, is ſoft, fawn coloured, ductile; it hardens and becomes brittle by drying: it is then inſoluble and unalterable This precipitation is ſo well adapted for characterizing the animal ſubſtances and eſpecially the gelatin, that by its quantity we may determine that of this principle as well as aſcertain its preſence. It is alſo found that tannin, which has become an uſeful re-agent in the animal analyſis, is the moſt powerful of the vegetable antiſeptics, ſince tanned ſkins experience no more ſenſible alteration and keep a long time without change. This property will, at ſome future period, afford an uſeful application to medicine; it may already be employed with advantage for anatomical preparations and for preſerving membranous organs.

6. *Gallin*

6. *Gallin* I term the impure gallic acid, combined with a ſmall portion of extractive, or of a vegetable principle hitherto unknown, in which its aſtringent taſte principally reſides. It exiſts almoſt always along with the tannin; it is not abſorbed by the animal matters, nor precipitated by the ſolution of glue: ſo that water ſaturated with tan, and afterwards deprived of tannin by the ſkins which have taken it from it, contains this gallin which is exhibited in it by precipitating the ſulphate of iron. Mr. Prouſt has ſeparated the gallin from the tannin, both contained together in a decoction of gall-nuts, by uniting it with muriate of tin which ſeizes the tannin by which the oxide of tin is precipitated, and leaves in the ſupernatant liquor the gallin with the muriatic acid. Citizen Seguin has diſcovered in the gallin the property of diſoxigenating or unburning animal matters, and of diſtending them, by ſwelling them in ſuch a manner as to diſpoſe them by this double effect to combine with the tannin. The uſe of the gallin as a re-agent may hereafter be carried ſo far as to enable us by its means to aſcertain the ſtate of oxigenation of the different animal ſubſtances.

7. Alcohol, the product of a ſpontaneous alteration of the ſaccharine matter that has been elſewhere deſcribed, has itſelf a very marked action upon the animal compounds; its effect is fourfold upon theſe compounds according to their different nature: it diſſolves ſome

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and may ſerve to ſeparate them; it coagulates others; ſome it preſerves and even hardens their texture.

It effects the ſolution of the animal reſins, of ſome colouring parts of animals, of ſeveral of their acids, of certain fats, eſpecially of that which I call *adipocire*, and which is found in the dried liver, in biliary calculi, &c.

It coagulates the albuminous liquids; it precipitates from them the albumen in ſmall flakes almoſt pulverulent which may be diſſolved in water, as Bucquet has remarked, at the moment when they have juſt been precipitated.

It preſerves and defends againſt putrefaction almoſt all the animal matters liquid or ſolid: it is employed for this purpoſe in anatomical laboratories, and even in medicine.

Finally, it hardens the texture, contracts and condenſes the fibres of moſt of the ſolids of animals; it condenſes and hardens their plates and laminæ.

ARTICLE

Article IX.

Of the Property of Forming Pruſſic Acid and ſome other Acids, conſidered as Character of the Animal Compounds.

1. THOUGH the diſcovery of Pruſſian blue, made in the firſt years of the eighteenth century by Dieſbach and Dippel, two chemiſts of Berlin, had at firſt only a colouring matter uſeful in painting for its object, it might ſince that time be thought that it would have a direct influence upon animal chemiſtry, as it really belongs to the ſubſtances of this nature, and was made by a chemiſt who had much occupied himſelf with theſe ſubſtances. However its relations with this kind of analyſis, and the characters which I now derive from it in order to diſtinguiſh the animal ſubſtances, were not very perceptible till after the experiments of Citizen Berthollet in 1787, and eſpecially till after a diſcovery made by myſelf, in 1790, upon the production of the Pruſſic acid, during the treatment of animal matters by the nitric acid. It required the labours of nearly eighty years to aſcertain this influence; and this is the reaſon why I think it incumbent upon me to give a ſomewhat detailed hiſtory of theſe labours

labours, or at least of the principal epochas which constitute it.

2. It was a little before the year 1710, that Diesbach, having borrowed from Dippel some alkali, in order to precipitate a lake, or extract from sulphate of iron, accidentally obtained a very beautiful blue. The latter chemist, knowing that this alkali had repeatedly served him for distilling and rectifying animal oils, easily reproduced this colour by precipitating sulphate of iron with a similar alkali. This discovery was announced in the Memoirs of the Academy of Berlin, in 1710. In 1724, Woodward described, in the Philosophical Transactions, the first process for preparing this new blue, which made much noise. It consisted in calcining in a crucible equal parts of ox-blood and pot-ash to redness, lixiviating the product with boiling water, mixing this lixivium with a solution of sulphate of iron and of alum, and employing muriatic acid in order to brighten the blue, which was washed with a large quantity of water. This very good process is still in a great measure followed in the workshops. The name of *lixivium of blood* was given to the liquor obtained from the alkali treated with this substance, afterwards dissolved in water, and thus disposed to precipitate the iron in the blue state.

3. The chemists zealously laboured upon this process, and at first sought various means for rendering the alkali capable of producing this

colour. Brown, in 1724, found that the alkali treated with flesh acquired this property in the same manner as with blood; and he endeavoured to explain its formation by means of a bituminous principle of iron, developed by the blood, and fixed upon the alumine. Geoffroy, the physician, discovered in 1725, that oil, wool, hartshorn, sponge, and even thyme calcined with alkali, give it the same action upon the sulphate of iron; he thence explained the blue before described in soda treated with the acids by Henckel: and he adopted the theory of Brown. Neuman endeavoured to treat the alkali with many different oils, and succeeded in communicating to it the tinging property by these inflammable bodies. Menon gave, in the Memoirs des Savans étrangers of the Academy of Sciences of Paris, a new theory of Prussian blue: he pretended that blue was the natural colour of iron, and that blood insulated it by purifying or refining this metal. Thus forty years passed without any other notion being added to the first discovery, except the possibility of obtaining blue with various matters different from blood, especially animal substances.

4. In 1752, Macquer, in an excellent Memoir, inserted amongst those of the Academy of Sciences, advanced the theory of this preparation a considerable step farther, by discovering the discolouration of Prussian blue by the alkalis. He showed that the alkaline leys became saturated with

this colouring matter, by caufing them to pafs over Pruffian blue till they ceafed to difcolour it, and again formed an abundant quantity of pure blue, when they were poured into a folution of fulphate of iron; that thefe faturated leys were in a ftate different from that of the immediate ley of blood, as this did not directly precipitate the iron into the blue, but in the grey or green ftate, on account of the portion of alkali not faturated. He fufpected that the colouring matter faturated the alkalis after the manner of an acid; that it adhered to them much in the fame manner as to iron, fince the fimple acids, according to him, did not difengage it from them; that in order to take it from them and transfer it to the iron, it was neceffary to employ a double affinity. He fubftituted, inftead of the vague theory of Brown and Menon, that of the alkali faturated by *phlogifton;* this was transferred again to the iron, which it furcharged by feparating it from the acids.

5. More than twenty years elapfed after the ingenious labours of Macquer, without any thing being added to his doctrine, which was adopted by almoft all the chemifts, who were then fatisfied with it. They contented themfelves with profecuting their refearches concerning the bodies capable of *phlogifticating*, as they expreffed it, the alkali; Weifman found this property in the empyreumatic oils; Model, in foot; Cartheufer in feveral vegetable afhes;

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occupied themſelves with this ſubſtance. This celebrated chemiſt undertook to aſcertain, both the compounds of which the Pruſſic acid forms a part, the properties of this acid, which before him no one had been able to inſulate, and its intimate nature, by decompoſing it, and alſo by forming it in a direct way with materials leſs complicated than the animal ſubſtances. His diſcoveries upon theſe different points are contained in two Memoirs inſerted in the Trimeſtres of the Academy of Stockholm, of December 1782, and January 1783. He began with examining the ley of blood: he ſaw that it was altered by the contact of gaſeous carbonic acid; that this acid diſengaged from it a vapour, which converted ſulphate of iron placed upon a ſtopper at the top of the apparatus into blue; that the ſulphuric acid alſo ſeparated it from it with the aid of diſtillation; that the Pruſſian blue, diſtilled with this acid, yielded an elaſtic fluid, which tinged the oxide of iron blue; that, when diſtilled alone, the Pruſſian blue yielded a portion of this colouring vapour, and ammonia ſaturated with it; that the ley of blood diſſolved a ſmall quantity of oxide of iron, which rendered it more ſolid and more permanent; that the iron eminently poſſeſſed the property of fixing the Pruſſic acid; that fire and the acids were nevertheleſs capable of volatilizing this colouring matter; that an alkaline ley, whilſt it diſcoloured the Pruſſian blue, diſſolved a ſmall portion of it entirely, and thus acquired a more durable

character than the ley of blood; that an acid distilled with the prussiate proceeding from the discolouration of the Prussian blue, precipitated from it an abundant quantity of real Prussian blue, because it was decomposeable only in its portion of alkaline Prussiate, and not in its ferruginous Prussiate.

8. After having discovered the possibility of obtaining the colouring matter of Prussian blue separate, and being able to observe its properties in its pure state, he sought the most speedy and most certain means of effecting this separation, which till then had been unknown to the chemists, who had not yet had this matter otherwise than combined with the alkalis and the metals: Scheele preferred the following process, which has been practised since his time. Two parts of Prussian blue, and one part of red oxide of mercury, are boiled in six parts of water till the whole is decolourated: to the lixivium is added half a part of iron-filings, and a little less of sulphuric acid; the mixture is distilled, and nearly a fourth of the liquor is drawn off, which is rectified by distilling it again upon chalk, in order to absorb the portion of sulphuric acid which it may contain. In this operation, the oxide of mercury takes away the Prussic acid from the oxide of iron, and is dissolved in Prussiate of mercury, white, crystallizable, &c. The iron, which is added in the metallic state, reduces the oxide of mercury, and at the moment when it unites with the sulphuric acid, added at the same time,

the heat which is employed volatilizes the Pruſſic acid ſeparated from the mercury, which has been reduced to the metallic ſtate. The Pruſſic acid thus obtained, partly in liquor and partly in gas, produces, when united with the alkalis, the ſame effects as the leys of blood and of decolourated Pruſſian blue. We ſhall ſoon return to its diſtinctive characters.

9. Scheele was not content with having found the means of inſulating and obtaining pure the colouring matter of Pruſſian blue or the Pruſſic acid; he wiſhed alſo to aſcertain what it was compoſed of, and conſequently to know how it is formed in animal matters. In order to determine its conſtituent principles, he firſt obſerved, that in the proceſs of abſtraction the air of the receiver was inflammable; that in decompoſing the Pruſſiates by fire, he obtained ammonia and carbonic acid; that ſome metals were afterwards found reduced by the diſtillation of theſe metallic Pruſſiates. He then ſuſpected that this acid was compoſed of ammonia and oil, and directed his ſubſequent reſearches upon this ſuppoſition; but he could not ſucceed in forming the colouring compound with ammonia and different oils or fats heated together. Obſerving that the water was an obſtacle to this formation of Pruſſic acid, he conducted his experiments in a different manner, by uniting ammonia with the dry inflammable principle which he admitted in the oils, and with the carbonic acid alſo dry.

He

of the peach tree, a taſte ſweetiſh at firſt, afterwards acrid and burning, the property of not reddening the blue colours, but of precipitating ſoap and the alkaline ſulphurets, that of combining with the alkalis, and of forming ſalts capable of precipitating the metallic ſolutions, and eſpecially thoſe of iron in the blue ſtate. He diſtinguiſhes amongſt the ſaline compounds of this acid, the Pruſſiate of lime, which he recommends, as being very pure, to ſerve as a teſt proper for aſcertaining and indicating the preſence of iron with certainty in waters, &c.; a teſt which the chemiſts have ſought with much care for a great number of years paſt. Two years before the labours of Scheele, in 1780, I employed this calcareous Pruſſiate, in my courſes of Lectures, as a teſt for aſcertaining the preſence of iron.

11. Such was the ſtate of the Science with reſpect to the colouring matter of Pruſſian blue, or the Pruſſic acid, when Citizen Berthollet communicated, at the cloſe of the year 1787, to the Academy of Sciences, a new inquiry in which he employed with great ſagacity, and by the aid of the new data of the French pneumatic doctrine, the experiments of Scheele, adding to them ſeveral others, and converted the ſtill uncertain and inadmiſſible theory of the French chemiſts into an explanation that agreed much better with the views of the modern chemiſtry. The reſult of his inquiry was, as it were, the reſult of the light which he had

thrown

thrown upon the nature of ammonia ſome years before. The compoſition of the one, once well known, muſt in fact have neceſſarily conducted him to the knowledge of the other, ſince even the reſearches of Scheele had already ſhowed a ſingular analogy between theſe two compounds, equally abundant amongſt the products of the animal matters.

12. The French chemiſt firſt proves that the alkaline Pruſſiate, formed by the diſcolouration of the Pruſſian blue, by means of alkali, contains iron; that its lixivium, being evaporated and afterwards re-diſſolved, yields octahedral cryſtals, the points of which are truncated near their baſes; that, mixed with ſulphuric acid and expoſed to the ſun, its ſolution depoſits Pruſſian blue, and is decompoſed; which does not happen to it in the ſame manner in the ſhade; that the Pruſſiate of mercury cryſtallizes in four-ſided priſms, terminated by pyramids with four faces correſponding with the edges of the priſms; that the muriatic acid diſengages more Pruſſic acid from it than the ſulphuric acid; that this acid, in decompoſing the Pruſſiate of mercury, forms a muriate in a ſingular ſtate.

13. After theſe preliminary experiments, he proceeds to the examination of the intimate nature of the Pruſſic acid by the action which the oxigenated muriatic acid exerts upon it. The latter, in proportion as it diſſolves in the Pruſſic acid, returns to the ſtate of ordinary muriatic

muriatic acid; the Pruſſic acid becomes more odorous, more volatile, leſs ſuſceptible of uniting with the alkalis, and precipitates iron in the green ſtate from its ſolutions. This green precipitate again becomes blue in the light by the contact of the ſulphureous acid, by iron: it is the oxigenated *Pruſſic* acid. By accumulating in it new oxigenated muriatic acid, which is made to paſs into it in gas, and by expoſing it to the light, water is ſeparated, to the bottom of which it is precipitated in the form of an aromatic oil, which heat reduces into an inſoluble vapour, that can no longer unite with iron. Thus ſuper-oxigenated, this acid can no more return to its firſt ſtate; it is far remote from its primitive nature.

14. The oxigenated Pruſſiate of iron, which is alſo prepared by treating the Pruſſian blue with the oxigenated muriatic acid, and is diſtinguiſhed by its green colour, loſes its acid which is ſuddenly converted into carbonate of ammonia by the contact of a fixed cauſtic alkali. The Pruſſic acid does not contain ammonia ready formed, as Scheele and Bergman thought; it contains only its elements, azote and hidrogen, both combined with carbon. When a ſufficient proportion of oxigen is added to this combination, the ſucceſſive addition of an alkali or of lime quickly deſtroys the Pruſſic compound by the pre-diſpoſing attraction which they have for the carbonic acid. Accordingly, Citizen Berthollet has been led by his experi-

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ments to confider the Pruffic acid as a combination of three fimple combuftible bodies; hidrogen, carbon and azote, the proportions of which, however, he has not found, though he has announced that thofe of the hidrogen and azote approach to the ammoniacal compofition.

15. This refult, which is much more precife than that of the Swedifh chemift, has furnifhed Citizen Berthollet with the means of eafily explaining the principal phenomena which the Pruffiates prefent, as well as the formation of the Pruffic acid. The following are the facts which he has efpecially confidered under this new point of view:

A. The metallic Pruffiates diftilled, yield carbonated hidrogen gas and carbonate of ammonia, and their oxides are more or lefs reduced; for the oxigen of the oxides, feizing the carbon, leaves the azote and the hidrogen to unite with one another; the oxigenated muriatic acid acts in the fame manner.

B. The animal matters form Pruffic acid in proportion to the azote they contain, which combines with the hidrogen and carbon.

C. In the experiments of Scheele, the muriate of ammonia heated with fixed alkali and charcoal is decompofed: it is by the elements of the ammonia and not by the entire ammonia that this falt contributes to the formation of the Pruffic acid.

D. The hidrogen, which forms part of this compound, is the caufe of the violent inflammation produced efpecially by the fuper-oxigenated muriate of pot-afh.

16. Citizen Berthollet, not having found oxigen in his experiments of decompofition upon the Pruffic acid, thinks himfelf authorized to conclude from thence that this acid contains no acidifying principle. On this occafion he examines the fingular nature of this compound; though he difcovers in its properties very remarkable differences between it and the other acids, he thinks, however, that it approaches the neareft to the nature of thefe bodies, and that it ought to be ranked in their clafs. He efpecially infifts upon its analogy with ammonia, and the tendency which it has to pafs into the ftate of this volatile alkali. He terminates his inquiry by the explanation of a very fingular phenomenon of attraction which the Pruffic acid prefents, and which Scheele had confidered as an irrefoluble problem; namely, that it cannot be feparated from the metals by the other acids, and that, neverthelefs, it cannot by itfelf take away from thefe acids the metallic oxides that are diffolved in them. He explains the apparent contradiction in the doctrine of affinities, by the great quantity of fpecific caloric which this acid when pure contains, and by the ftrong tendency which it has to affume the gafeous form.

17. We

17. We fee from the ingenious refearches of Citizen Berthollet that the production of the Pruffic acid by the decompofed animal matters, whilft it exhibits one of the moft proper characters for diftinguifhing them and afcertaining their nature, prefents a property fingularly related with that of forming ammonia. But in what does this property of affording Pruffic acid or ammonia precifely refide? and what is the caufe which determines the production of the one rather than the other? In order to folve this queftion, which is of great importance to Animal Chemiftry, it is to be obferved, that the formation of ammonia fuppofes a more advanced decompofition than that of the Pruffic acid, as the one reprefents a binary compound, whereas we ftill find in the other a ternary compound, more approaching to the nature of the primitive animal matter by its very complication. In the fecond place, it is to be remarked that the production of the Pruffic acid is not fenfibly favoured, or does not take place in any abundance except when we treat the animal matters by a fixed alkali, efpecially aided by a metallic oxide; it is, therefore, the pre-difpofing attraction, exerted by two bodies at the fame time, which ought to be confidered as the caufe of this formation of Pruffic acid. Finally, it muft not be omitted, that the production of the Pruffic acid never takes place except in a very fmall quantity comparatively with that of the animal fubftances which afford it, that it amounts

amounts only to ſome thouſandths or at moſt to two or three hundredths; and that the carbonate of ammonia which they afford is in a quantity twice or thrice as conſiderable, on account of the carbonic acid which ſaturates it, and which is formed at the ſame time.

18. In 1790, three years after the inquiry of Citizen Berthollet, I pointed out a new fact, which I thought adapted to elucidate the nature and the formation of the Pruſſic acid. In treating the ſerum of coagulated blood by the nitric acid, I was ſtruck with the ſmell of Pruſſic acid. The vaporous product diſengaged in this experiment having been collected, I found it to be real pure Pruſſic acid; I even obtained a ſufficient quantity of it to induce me to believe that this very ſimple proceſs might be ſubſtituted inſtead of that of Scheele, which is much more complicated, in order to obtain this acid; azotic gas had been diſengaged with it and carbonic acid gas was formed. This led me to think that a ſimple change in the proportions of the conſtituent principles of the animal matters was ſufficient to give riſe to the Pruſſic acid; and that, as in the formation of the nitric acid, azotic gas had at firſt been diſengaged, there was reaſon to believe that this acid contained leſs azote than the ammonia, ſince in the formation of the latter this principle was not ſeparated before that formation had taken place. It cannot therefore be admitted, either that the Pruſſic acid is a ſolution of carbon in ammonia, as Scheele

Scheele had preſumed, or that it contains azote and hidrogen in a proportion nearly approaching to that which forms ammonia, as Citizen Berthollet had announced. This opinion of the quantity of azote proportionably larger in the Pruſſic acid than in ammonia may even be ſupported by one of the facts which had been well obſerved by the latter chemiſt; I mean, the diſengagement of a certain quantity of carbonated hidrogen gas during the formation of the carbonate of ammonia, which accompanies the decompoſition of the Pruſſic acid by fire. Neither does it appear to me to be well proved that this acid ought to be conſidered as wanting oxigen, and as formed merely by the union of three ſimple combuſtibles, both becauſe Citizen Berthollet who has propoſed this opinion has not made an accurate analyſis of this acid, and becauſe the compariſon which he has eſtabliſhed between this acid, the muriatic acid, and the ſulphurated hidrogen, is very far from being equivalent to a proof; and finally, becauſe the conſtant production of the carbonic acid in all caſes of the decompoſition of the Pruſſic acid, even not previouſly ſuper-oxigenated, the ſix-times more conſiderable quantity of Pruſſic acid obtained by Citizen Vauquelin, in decompoſing muriate of ammonia mixed with charcoal by the oxide of lead, than that which he obtained in performing the ſame operation with lime inſtead of oxide of lead, militate ſtrongly in favour

favour of the adoption of oxigen in this acidified compound.

19. The formation, the nature and the properties of the Pruſſic acid, as a characteriſtic production of the animal compounds, are ſo neceſſary to be accurately known in order that we may form a right conception of the properties of theſe compounds, that it appears indiſpenſable to me here to enumerate the ſeries of properties that belong to this important product, conſidering it as inſulated, and prepared either by the proceſs of Scheele, or by that which I have indicated (No. 18):

A. The Pruſſic acid has a ſtrong odour of peach-bloſſoms or of bitter almonds. This ſmell impregnates for ſome time the ſaliva of thoſe who reſpire it.

B. Its taſte, which at firſt is ſweetiſh, ſoon becomes acrid, hot and virulent; it excites coughing.

C. It has a great tendency to aſſume the gaſeous form, and frequently ſome of it is loſt in this form in the veſſels into which it is received.

D. It is decompoſed at a high temperature, and by the contact of light: it is thus changed into carbonic acid, ammonia, and carbonated hidrogen gas.

E. It combines with the alkaline baſes with difficulty, and without deſtroying their alkaline property.

F. Its

F. Its weaknefs, already proved by the preceding property, permits the carbonic acid to difplace it from the alkaline Pruffiates.

G. It takes oxigen from the oxigenated muriatic acid, and its nature is changed by the addition of this principle.

H. It does not act upon the metals; it unites with their oxides, the colour of which it changes, and with which it forms in general infoluble falts.

I. It has a great propenfity to form triple falts with an alkaline and metallic bafe. Thefe triple Pruffiates, thefe complex combinations are more permanent and more fixed than the fimple alkaline Pruffiates; they are no more decompofed by the carbonic acid, light, the air and the acids.

K. When it is united with the metallic oxides, it cannot be feparated from them by the acids, as in thefe combinations it acquires a great fixity and a great adherency; and yet when it is infulated, it cannot carry off the oxides of the metals from the other acids, on account of its fpecific caloric, and its tendency to affume the ftate of gas.

L. According to the refearches of Citizen Berthollet and Mr. Prouft, there are two fpecies of metallic Pruffiates, the fimple and the fuper-oxigenated: there is even reafon to believe that with refpect to iron there are three, the white, the blue and the green, the progreffion being made from the moft to the leaft oxigenated.

M. The

M. The super-oxigenated Pruffic acid is very near to decompofition; the mere contact of a fixed alkali deftroys it and converts it into carbonate of ammonia, becaufe the oxigen being fufficiently abundant, and attracting the carbon, permits the azote to unite in particular with the hidrogen to form ammonia; the hidrogen exceeding the proportion of the latter compofition is difengaged in carbonated hidrogen gas.

20. The nature, the compofition, the decompofition of this acid being once well demonftrated, its relations with the animal matters which produce it are ftill better determined by the confideration of the different principal circumftances of its production. I find four of them which equally demonftrate a like feries of decompofition that takes place in thefe matters.

A. The action of fire; we have feen that it is obtained amongft the products of the bones, the blood, the urinary calculus; it is combined in them with ammonia.

B. The action of the nitric acid; when this acid is weak, it firft difengages azote from the animal matters; when it is ftrong and concentrated, it immediately volatilizes Pruffic acid from them, and at the fame time are formed carbonic acid, oxalic acid, and the adipocirous matter.

C. The action of the fixed alkalis; the animal fubftances, heated by a ftrong fire with the alkalis, faturate them in part with Pruffic acid after they have been reduced to coal.

 D. Finally

D. Finally putrefaction, by deftroying the animal compofition, fometimes gives rife to Pruffic acid, which eafily finding oxide of iron, combines with it and gives it a blue colour; hence proceed the native Pruffian blues defcribed by feveral naturalifts.

21. What I have juft fet forth concerning the Pruffic acid may be applied to fome other particular acids of animals, though they be few in number; for we muft not rank in this clafs the oxalic, acetous, febacic acids, which being found the moft frequently amongft the products of the vegetable matters, have the compofition and all the chemical characters of fuch matters. When thefe acids are formed in the animal fubftances they really belong only to thefe matters in a retrogradation towards their firft origin, or in fome meafure defcending, by a commencement of decompofition, to the condition of vegetable fubftances. I know fcarcely any other than the zoonic acid difcovered by Citizen Berthollet, the uric acid conftituting one of the fpecies of the human urinary calculi, and one of the materials of arthritic concretions, the lactic acid, and perhaps the acids of infects, which appear to belong to this clafs of animal acids, wher they do not prefent all the properties of acetous acid, like the former acid. The moft marked character of thefe animal acids is that they can be converted into Pruffic acid by chemic means; they alfo deferve to be examined an der this point of view, efpecially the zoor

the lactic, and the uric acids, which are very little known with respect to their intimate composition.

ARTICLE X.

Of Putrefaction, considered as Characteristic Property of the Animal Substances.

1. THE last and one of the most striking characters which distinguish the animal from the vegetable matters, consists in the kind of spontaneous decomposition which they experience, and which is called putrefaction. Though the vegetable substances are not exempted from this decomposition; though nature has subjected them to this law which equally embraces all the organic matters, the slightest observation is sufficient to show that putrefaction is infinitely more powerful and more rapid in the animal compounds, which are more disposed to it by their very composition, and that it establishes itself in them, develops itself and goes through its periods with much greater activity. It is not necessary to present it here as an intestine motion which tends to change the nature of the substances which experience it; for all that has already been said, both in the history of the vegetable substances, and in the preceding articles concerning the animal matters render this sufficiently evident.

2. It is already a long time ſince philoſophers and naturaliſts have acknowledged all the intereſt which the ſtudy of putrefaction preſents for the ſciences, and eſpecially for the art of healing. Lord Bacon firſt pointed out its utility for medicine; he was the firſt who invited phyſicians to occupy themſelves attentively with it, and eſpecially with the intention of diſcovering means for preventing it, retarding it, even ſtopping its progreſs, or re-eſtabliſhing the ſubſtances which had experienced it in their natural ſtate.

Becher has made a remarkable table of its phenomena, and enunciated its grand effects in the order and ſucceſſion of the changes which the globe experiences: Stahl his commentator has added nothing to this table.

Pringle, an Engliſh phyſician, has made a great number of experiments upon the ſepticity and antiſepticity of bodies, and has opened an immenſe career for the doctrine of antiſeptics.

Citizen Giobert of Turin has repeated them and added to them ſeveral new ones.

A French lady, who has rendered herſelf eminent by a great number of ſcientific productions, eſpecially by her tranſlation of Shaw's Courſe of Chemiſtry, has given a numerous ſeries of experimental inquiries upon the ſame ſubject.

Macbride, a ſurgeon of Dublin, opened a new career immediately at the firſt period of the diſcoveries upon the elaſtic fluids, in 1766. He

He eſtabliſhed a new theory of putrefaction and the antiputreſcents, and attributed the firſt to the diſengagement of fixed air or the carbonic acid and the reſtoration of the putrid matters to the reſtitution of this principle. Though this theory has been diſcovered to be erroneous, ſince it has been known that the carbonic acid is not contained ready formed in the animal ſubſtances, and that it acts only as acid, not as principle of theſe ſubſtances in its antiputreſcent energy, yet the efforts of this able chemiſt have conducted us to new and uſeful conſiderations upon this ſpontaneous motion.

Boiſſieu, Bordenave and Godart, in three Memoirs which gained the prize and the acceſſit propoſed upon putrefaction in 1767, by the Acadamy of Dijon, have alſo given uſeful obſervations upon this natural alteration, and have eſtabliſhed the baſis of doctrine for determining its cauſe, phenomena and reſults.

Finally, the labours of the moderns, eſpecially Citizen Berthollet, and the data afforded by the pneumatic doctrine threw a new light upon this kind of fermentation and furniſhed a more exact explanation of its circumſtances and products.

3. A firſt fact which muſt be inſiſted on, relative to putrefaction, is the extreme facility with which it eſtabliſhes itſelf, and the rapidity with which it goes through its periods in the animal ſubſtances: the cauſe of this ſtrong tendency, which is not found in the immediate materials of plants

plants, neceſſarily depends upon the difference of nature which diſtinguiſhes thoſe two claſſes of organic compounds. It has been ſeen in all the preceding articles, that the animal compoſition differs from vegetation by a greater number of conſtituent principles, and by the proportion of theſe and the principles that are common to both. The azote added to the hidrogen, the carbon, and the oxigen, the ſuperabundance of the hidrogen in the animal compounds, the phoſphorus and ſulphur which are very frequently combined with theſe firſt principles, complicate their production and are the ſource of the more numerous and more varied products which are obtained from them by the different agents to which they are expoſed. The multiplied attractions which exiſt between their more numerous conſtituent elements render their equilibrium more eaſy to be deſtroyed, and induce at the ſlighteſt variation of circumſtances, a decompoſition, or change of nature, which quickly gives riſe to other products more varied than are obtained from the vegetable ſubſtances. Life ſupports and maintains with more or leſs force this equilibrium, this permanency of ſtate, and it is in this that it conſiſts; but death permits the firſt principles to re-act in particular the one upon the other. This ſpontaneous re-action muſt then be more prompt, more profound and more effective, as it takes place amongſt ſubſtances more numerous, and by virtue of attractions more multiplied?

plied: it is therefore essential to the animal matters to be more putrescible than the vegetable.

4. As whatever belongs to putrefaction presents a great interest to the science and to its numerous applications, the history of this alteration requires to be exhibited with a method sufficiently strict to omit nothing essential, to place every fact, every truth in the suitable light, to give to each the evidence and the force which belong to it, and to form of all a collective whole: I shall therefore treat successively and in a series of numbers;

A. Of the preliminary conditions of putrefaction;

B. Of the general phenomena which accompany it;

C. Of the existence of particular phenomena which may serve to characterize each animal matter;

D. Of the influence which the different media have upon it;

E. Of the different products to which it gives rise;

F. Of the last residuum which it leaves;

G. Of the causes which determine it; of its nature, and of the principles in which it consists;

H. Of its effects upon the living animals;

I. Of the means of remedying it;

K. Of those of preventing it;

L. Of those of stopping it, or of the antisceptics;

M. Of

M. Of the principal applications which all theſe facts offer to medicine;

N. Of the products which men have derived from it for their wants.

Each of theſe ſubjects requires only a mere ſketch, as the preſent object is only to connect them with what has hitherto been ſet forth concerning the general characters of the animal matters, to derive from them a general notion concerning their chemical properties; and as beſides the generalities, new details will be given in the hiſtory of each animal matter in particular.

5. Though the abſence of life has already been announced at leaſt as a condition eſſential to putrefaction, as the energy and the power of the vital principle actually oppoſes this motion its exiſtence is admitted only when this energy is weakened, and in ſome particular caſes.

Death is not the only condition neceſſary to putrefaction; there is alſo required the combination of ſeveral other circumſtances without which it would not take place. Theſe may be reduced to moiſture and moderate heat. It is proved by a great number of facts that the dry animal matters do not putrefy; the bones, dried meat, and anatomical preparations keep without alteration; bones ſoftened by water, the ſoft fleſh, and eſpecially the animal liquids, paſs on the contrary rapidly into putrefaction: it even principally follows the proportion of the quantity of water which exiſts in the animal ſubſtances.

ſubſtances. It is no leſs aſcertained that there can be no putreſcence at the freezing temperature and below it; but that the ſeptic alteration commences at ſix or eight degrees above it; and proceeds in a progreſſion the more rapid, as the temperature of the ſubſtances which experience it is more elevated. This condition, however, has its limits; heat near the temperature of ebullition, and even that which exceeds from 45 to 50 degrees of Reaumur's ſcale, no more permits putrefaction than the cold; it even defends the animal ſubſtances againſt this motion, as it tends, either to dry them, or to condenſe their texture or coagulate their maſs, or to decompoſe them in another manner. The proportion of the elements which here act as conditions of putrefaction produce ſome modifications in it; water accellerates it by its quantity; the abundance of caloric ſometimes joins the effects of partial volatilization with thoſe of the putrid decompoſition. It was long believed that the contact of the air was neceſſary to putrefaction; but it is certain that as it takes place in a vacuum, and in ſmall proportions of air not renovated, the contact of the latter is only a condition which accelerates the putreſcence, not by the influence which it exerts of itſelf upon the animal ſubſtances, but merely by ſerving as a recipient for diſſolving and carrying off the materials that raiſe themſelves in vapour. It is to the ſame claſs that we muſt refer the diminution of preſſure, which ſome authors have conſidered as one

of the cauſes of putrefaction: we ought not to omit amongſt the conditions of putrefaction the admixture of fermented matters, and eſpecially of thoſe that are putrefied with the freſh ſubſtances: this ferment acts by raiſing the maſs, and accelerates and develops the putrefactive motion.

6. When the conditions of putrefaction, namely, an animal ſubſtance deprived of life, moiſt and expoſed to a temperature above 10 degrees, are combined, this motion eſtabliſhes itſelf; the animal ſubſtance ſoftens if it was ſolid, or becomes thinner if liquid; its colour changes, and inclines more or leſs towards the red-brown, or the dark-green; its odour is altered, and after having been at firſt faint and diſagreeable, it becomes fetid and inſupportable. An ammoniacal ſmell ſoon mixes with the firſt, and deprives it of part of its fetidity: this is only temporary, whilſt the putrid odour exiſting before it, ſtill remains after it and ſubſiſts during all the phaſes of the putrefaction. The liquids become turbid and filled with flakes; the ſoft parts are melted into a kind of jelly or putrilage; there is obſerved a ſlow motion, a ſlight inflation which raiſes the maſs, and which proceeds from bubbles of elaſtic fluids, diſengaged ſlowly and in ſmall quantities at a time. Beſides the general ſoftening there runs out a ſeroſity of different colour which conſtantly augments; gradually the whole maſs melts, this ſlight inflation ceaſes; the matter ſinks, the colour grows er; at length the ſmell becomes frequently

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as it were aromatic and approaches even to that which is termed *ambrosiacal ;* finally the animal substance diminishes in mass, its elements evaporate and dissolve, and there remains nothing more than a sort of fat, viscous earth, still fetid.

The duration of this putrid decomposition, though varied, presents four very distinct periods which Boissieu has carefully distinguished: the first, or that of the *tendency* to putrefaction, exhibits an alteration that is still but slight; it presents only the musty smell, the softening of the substance and a slight change of colour; the second, or the *commencing* putrefaction, sometimes affords signs of acidity: the softening is more considerable; the serosity begins to escape from the relaxed fibres; the colour is more altered and the fetid odour already putrid. In the third degree of the *advanced* putrefaction, the odour which is always fetid, is more or less ammoniacal; the matter dissolved into putrilage is of a dark colour; it has lost much of its weight by the disengagement of a large quantity of volatile principles. The last degree, or the *accomplished* putrefaction, no longer presents the ammoniacal odour; the fetidity is supportable, slight or none at all; an aromatic odour frequently succeeds in the place of it; the animal matter has lost a great part of its volume and all appearance of organization; there remains nothing more than an earthy residuum, of a

blackiſh-brown colour, fat to the feel, which in this ſtate is called *animal mould.*

7. Theſe phenomena vary according to the different animal matters; the difference of their nature and the different proportion of their principles are the ſource of them. It may even be ſaid that each animal ſubſtance has its different manner of comporting itſelf in putrefying. Hence, all the varied and diverſified ſcenes, which have been deſcribed by different authors, and of which we find a faithful account, both in the ſingular work of the phyſician Garman, entitled *De miraculis mortuorum,* in which are detailed the ſlow and ſucceſſive changes of all the parts of the human body in the cemeteries, and in the *Eſſay on putrefaction* by Madame Darconville. But as this object belongs to the hiſtory of each animal ſubſtance conſidered in particular, I mention it here only in order to eſtabliſh the principle of this variability of phenomena: it ſhall be treated of in each of the ſubſequent articles.

8. It is alſo a variation independent of the animal matter, and ſubjected only to that of the ſurrounding bodies, which I muſt here conſider in general under the title of the influence of the media in putrefaction. The ſingle obſervation drawn from the different cuſtoms of nations with reſpect to their dead, or from the poſition of the carcaſes of animals placed in different circumſtances, according to the places in which they ar deprived of life, ſufficiently

proves

proves this remarkable variation. The bodies are ſeen altered in a different manner amongſt the nations of the South Sea, who expoſe their dead in the air, upon elevated places, in the cabins of boughs of trees of their morais, upon the ſummits of trees; amongſt the nations who immerſe them in the water; and amongſt the more poliſhed nations who immerſe them in the earth. I have ſaid elſewhere that the animal parts placed in water are converted there into fatty ſubſtance; an alteration nearly ſimilar takes place in moiſt earth: but the greateſt difference which is of importance to be conſidered here, is that which takes place in the air, relatively to the phenomena which accompany putrefaction in cloſe veſſels. I have ſuppoſed this latter circumſtance in deſcribing (No. 6) the general phenomena of the putrid alteration. In the air, a portion of the entire animal ſubſtance is carried away and diſſolved by the atmoſphere; the products which are volatilized are equally carried away and diſſolved by the air. The total and complete deſtruction of the animal ſubſtance is effected with more or leſs rapidity. All the events of this decompoſition are much nearer to one another, as the exterior agents contribute to ſeparate the elements of the matters which putrefy. Here the animal matter at laſt completely diſappears, ſince after what the air receives of volatile principles, the ſmall quantity of earthy reſiduum which eſcapes this aëriform ſolution penetrates gradually

gradually into the earth, where it is buried and carried away by the filtration of the waters.

9. Though we may rank amongſt the phenomena of putrefaction, the matters which are diſengaged from the putreſcent animal ſubſtances, I ſhall conſider them here in particular as products, becauſe they proceed from the action of this motion itſelf, and becauſe it is important to know them with more accuracy and preciſion than the mere inſpection or even obſervation of theſe phenomena would permit. In order to determine the nature of theſe phenomena, to follow with attention the ſeries and the epochas of their diſengagement, and conſequently to know in what the decompoſition of the animal matter conſiſts, it was neceſſary that a conſecutive analyſis of the putrid vapours, an attentive examination of the putrefied matters, ſhould ſupply the place of the theory which had attempted to divine their characters. Thus it was long believed that the ammonia or volatile alkali was the ſole product of putrefaction, and it was on this account that it had been called *alkaline fermentation*, in oppoſition to that which gives riſe to the acetous acid: but though ammonia is indeed one of the principal products of this ſpontaneous motion, it is not the only one; there are others, the production of which precedes, accompanies, or follows its production, and which deſerve to be known and ſtudied with equal attention. There are even ſome animal

animal matters the ſeptic decompoſition of which commences with an acidification.

We ſhould have only an imperfect and ſuperficial notion of theſe products, if, after being aſſured that they are not the ſame nor in the ſame proportions with the different animal matters, we did not endeavour to approximate all theſe various products, to collect under a ſingle point of view all the ſubſtances afforded in the putrefaction of the different animal compounds, and thereby embrace the totality of theſe products.

It is then found that the animal ſubſtance ſucceſſively gives riſe, in its putrid decompoſition, to carbonated, ſulphurated, and phoſphorated hidrogen gaſes, which carry and propagate its infection far and wide; to water, which is diſengaged in vapour, to ammonia, and to carbonic acid gas. All theſe bodies eſcape, are diſſipated and volatilized; they carry off with them combined two and two together, the principal primitive materials of the animal compound. Other products, formed at various periods, as acceſſary circumſtances of the compoſition of each animal matter, differ from the preceding by their fixity, and remain in this matter more or leſs ſolid and fixed: ſuch are the zoonic acid, a fat matter, a kind of ſoap formed by this fat and ammonia; ſuch is alſo the nitric acid, frequently formed in this decompoſition, and fixed by an earthy or alkaline baſe; ſuch finally is the unctuous mould which remains after the ſeparation

tion and the disengagement of the preceding products. Thus the animal matter is gradually separated, divided and destroyed: we shall soon see how these products are formed and succeed each other.

10. It is especially useful to distinguish, amongst the products of the putrefactive motion, that which is its last result, that which, after the disengagement of all the volatile materials, remains fixed, and constitutes the residuum. Its small quantity, its contracted volume, its earthy form very remote from organization, of which it presents nothing more than the wrecks or the most solid matter, have at all times fixed the attention of the philosopher. The remains of a large mass of organized matters, of which it forms only some hundredth parts, it has long been considered as a particular earth, which was distinguished by the name of animal earth. But this denomination, derived from its pulverulent state, its insipidity, its inodorous quality, as well as its fixity and insolubility, is inaccurate and erroneous, since this residuum, this animal mould, contains, besides the acids and the earths combined in the saline state, a portion of fat coally matter, which, when distilled, still yields oil, carbonate of ammonia, and leaves a coal charged with earthy phosphates. The fixed, saline, earthy and metallic matters which constitute the nature of this residuum, retain for a long time a portion of oily substance more or less concrete, which is destroyed only very slowly;

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and in order that they may be reduced to the pure faline and earthy ftate, analogous to the afhes which remain after combuftion, it almoft always requires a long feries of years. Thus carcafes buried in the earth are not reduced to their dry fkeleton, and do not lofe the laft remains of their foft parts, till after a lapfe of time, which generally exceeds feven years, and which is fometimes prolonged to more than thirty. The excavations in the ground of the cimetery of the Innocents at Paris have proved this to me in an inconteftible manner; it is eafily conceived that the proportion and the nature of this refiduum correfpond entirely with thofe of the fixed matters, which formed conftituent parts of the animal compounds, and that they muft vary according to each of thefe compounds.

11. As we have now feen the conditions of putrefaction, the phenomena which it prefents to the obferver, the general influence which it receives from the mediums in which it acts, the different products which it affords, and the refiduum which it leaves, it is time to occupy ourfelves with its intimate nature. It is not enough to have confidered it as a flow decompofition, as a fpontaneous analyfis, as a deftructive fermentation of the organic compounds, becaufe it has all the characters of the inteftine motions which are defignated by this name in chemiftry; it is neceffary that we fhould penetrate more intimately into its caufe, to afcertain and explain its mechanifm. It is evident that it confifts in

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a change effected by a sum of attractive forces superior to those which keep the principles of the putrescent substance united. These principles are, as we know, hidrogen, azote, carbon and oxigen, with which are frequently associated sulphur, phosphorus, and different kinds of phosphates.

It is evident that, in putrefaction, part of the hidrogen unites with the azote to form ammonia; another part of the hidrogen combines with a portion of oxigen with which it constitutes water; that a certain quantity of carbon, combined with a relative quantity of oxigen, gives rise to carbonic acid; that a portion of azote united with a third quantity of oxigen produces nitric acid; that a combination of hidrogen, carbon and azote forms the volatile or the fixed oil, according to the proportion of these principles; that another combination between the same matters and oxigen composes the zoonic acid; and that finally, the saline, earthy, and metallic substances, being unalterable, or little alterable by the intestine motion of putrefaction, remain untouched and passive in the last residue of this spontaneous motion, carried to its *maximum*.

It is no less evident that these matters or new compounds, which did not exist originally in the animal substances, unite two and two together, the ammonia and the carbonic acid, the ammonia and the zoonic acid, the ammonia and the oil which it reduces to the saponaceous

state.

ſtate, and are diſengaged in this form in the air, or diſſolved in the water. All theſe new compoſitions, which are leſs complex than the primitive compound which gives riſe to them, and which are the products of its ſlow diſſolution and the indications of its deſtruction, are the conſequence of numerous attractions which act amongſt the multiplied principles of the organic compound deprived of life.

We may comprehend in a general formula the totality of all theſe attractions, and expreſs with preciſion what takes place in putrefaction, by ſaying that the ſum of the forces which tend to unite the hidrogen with the azote, the oxigen with the carbon, the carbonic acid with the ammonia to form the ammoniacal carbonate, and the hidrogen, the carbon, and the oxigen to produce oil; this latter with the ammonia to conſtitute a ſoap; and finally, the hidrogen with the oxigen to produce water, and the latter with all the preceding compounds,—that this whole ſum is ſuperior to the ſum of the forces which retain in quaternary combination the hidrogen, the azote, the carbon and the oxigen, to conſtitute the animal compound.

We have here repreſented only the alterant action of theſe forces, and the putrefactive effect which reſults from them in cloſe veſſels, into which nothing extraneous to the organic ſubſtance can enter, and from which nothing can eſcape; for though the reſults are ultimately identic, they take place in a very different

manner in the midst of the atmospheric air. In the latter circumstance, a part of the animal substance is dissolved and carried off conjointly and separately by the air and by the water; the ammonia and the carbonic acid are volatilized as fast as they are formed; a portion of carbonated hidrogen is volatilized by the alteration of temperature: and there is formed neither fat matter nor ammoniacal soap.

Thus may be explained in a simple manner the phenomena and the products of putrefaction; and thus its conditions, its varieties, its duration, &c. may be comprehended. It was natural to consider them as inexplicable, as long as the nature of its products, that of the water, of the ammonia, of the oils, and of the acids, were involved in an obscurity which necessarily extended itself over the progress and the mechanism of this kind of fermentation. This obscurity has, as we see, been dispelled by the efforts of the pneumatic chemistry which has left nothing unintelligible in the knowledge of this spontaneous decomposition. This is one of the fruits which we owe to its progress and its happy revolution.

12. Amongst the phenomena dependant upon putrefaction which it is of importance to consider, must be reckoned the dangerous effects which it produces upon living animals. If we except a very small number, belonging to the last classes of these beings and endowed with the least sensibility, there are none which an animal matter in the state of putrefaction does not deter

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and repel from the place where this ſcene of death and deſtruction is exhibited. By the diſguſt with which it inſpires them, by the haſty flight which it occaſions, it is eaſily conceived that this phenomenon is inimical to life, and that it threatens it with remarkable energy. Accordingly, the greater number of animals cannot feed upon animal matters putrefied to a certain degree; and though ſome of them, being indolent and ferocious at the ſame time, devour carcaſes already tainted, none make them their food when the putreſcence is too far advanced. We know the averſion and diſguſt which all mankind have againſt corrupted animal matters, the diſagreeable effect which they produce upon their organs, and the repugnance which their ſenſe of ſight and ſmell experience at the mere aſpect of theſe matters. Frequently the putrid miaſmata or the gaſes which are exhaled from bodies in the ſtate of putrefaction, are ſo deleterious, that men and animals are deprived of ſenſe by their contact. When they do not produce this ſudden effect, they occaſion putrid diſeaſes in ſuch as are expoſed to them. Some individuals contract external affections, carbuncles, malignant and gangrenous puſtules by the corruptive action of theſe vapours; others are influenced by them in a much more dangerous manner, for beſides a conſiderable proſtration of the powers of life, they become affected with putrid fevers of the moſt malignant character. It is not yet known what is the nature of the putrid

putrid gas from which thefe terrible effects arife: it is not the azotic gas, as fome modern phyficians have thought, who on that account have given it the name of *fepton* or rather *feptic gas.* There is reafon to fufpect that they ought rather to be attributed to the action of the putrefied animal matter itfelf, which being diffolved in the gafes exhaled during its putrefaction, carries into the organs which are the focus of life its benumbing or debilitating principle, and pours into the torrent of the animal humors the putrid germe or ferment, which they are unfortunately fo much difpofed to receive.

13. Science, whilft it enables us to afcertain the fource and the caufe of thefe terrible effects, furnifhes us with arms for preventing or determining its influence. Two means prefent themfelves, fuggefted by reafon and confirmed by experience: the one, which belongs to the police and the wifdom of government, confifts in removing from populous places, particularly from large towns where the accumulation and crowded fituation of the inhabitants is already a pre-difpofing caufe of putrid difeafes, the fources of infection and putrefaction. To aërate the habitations, to eftablifh a frequent ventilation in them, to cover the common fewers, to remove finks of all kinds, to eftablifh burial places out of the towns, to kindle large wood-fires in fuch fituations that the wind may carry the fmoke into the places which we wifh to preferve, to obtain a profu-

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ſion of freſh and running water in open canals, and eſpecially to cauſe it to aſcend in fountains or precipitate itſelf in caſcades; theſe are the grand means of preventing putrefaction or at leaſt of repelling its invaſions. The other means, more confined in its application, and practicable only in ſmall ſpaces or in circumſcribed places, has for its object to deſtroy the putrid miaſmata themſelves, to fetter their activity, and to neutralize their virulence. This effect is obtained by the diſengagement of the muriatic acid in gas, and eſpecially by the oxigenated muriatic acid, which I conſider, and which I propoſed ſome years ago, as the greateſt external antiſeptic, becauſe it attacks and deſtroys the animal combination which conſtitutes the virus. Its advantages and uſe in this point of view will be the better underſtood, in proportion as the principles of chemiſtry ſhall be diffuſed in the work-ſhops and become familiar to manufacturers and artiſts.

14. Art has always ſought the means of preventing the putrefaction of animal matters, and defending them againſt corruption. The number of means and matters of this kind which it has diſcovered is very conſiderable; the principal are, as is eaſily conceived, all the proceſſes which deſtroy the conditions that give riſe to it. Thus the deſiccation of animal matters, the privation of water, refrigeration, or preſſure, are the firſt and moſt certain, becauſe by their ſimple influence, they make the

the causes disappear which develope putrefaction. Many substances with which the animal matters are enveloped or which penetrate their texture answer the same purpose. The acids, the salts, the aromatics, sugar, the fixed and volatile oils, the resins, camphor, the powder of dry and odorous plants, of acrid resinous bitter woods; charcoal, generous wines, alcohol; the bitumens; particularly possess this property; accordingly, these are the substances which are employed with the most security for preserving animal matters in the art of embalming, salting, in condiments, macerations in vinegar, &c.

15 Medicine has been occupied with a particular interest in the research of substances capable of retarding or stopping the progress of putrefaction which frequently manifests itself in some parts of the diseased human body; it has called them *antiputrescents* or *antisceptics*. On comparing them with those already indicated we find great analogies between them.

Godart observes that all the possible antiseptics may be reduced to three classes:

A. The refrigerants, which comprehend all the means of diminishing heat, the great influence of which upon putrefaction we already know. He ranks in this class: cold, the aqueous substances, the farinaceous matters, the acids, and the sedative.

B. The ventilants or those which dissipate the

the putrid miasmata, are the agitation of the air, the evacuents, the cordials;

C. The corroborants, which condense or contract; amongst which he enumerates the acerb, the astringent, and the bitter substances.

Bordenave has referred the medicinal antiseptics to six classes; namely, the antirelaxants, the stimulants, the astringents, the balsamics, the desiccants and the caustics.

Bossieux, in a very extensive and very methodical table, has presented their series distributed into a great number of ingenious divisions, which it is not my object here to exhibit. In all the considerations relative to these agents, there have especially been distinguished the sulphuric acid, the carbonic acid, the vegetable acids, the Peruvian bark, Scorduim, Guaiacum-wood, camphor, tannin, the gall-nut, alcohol, the metallic salts and their solutions: some have even gone so far as to pretend to restore flesh already in a very advanced state of putrefaction to its original condition. Macbride has more especially attributed this effect to carbonic acid, because putrified flesh immersed in it resumes a part of its colour and consistence: but it is very evident that this is an exaggerated pretension, and that nothing more has been effected than the separation of the exterior part, the most advanced in putrefaction, from the still sound portion; for science teaches us that it is impossible to form anew an animal matter that has been destroyed, and that we cannot in this

this respect surpass Nature, who herself is subjected to the impossibility of making a retrogade step in this putrefaction.

16. After all the preceding considerations, it cannot be doubted that putrefaction is a slow decomposition, a kind of spontaneous analysis effected by virtue of complicated attractions, existing between the numerous principles of the animal matters, namely, the hidrogen, the azote, the carbon, the oxigen, the sulphur, and the phosphorus; that the motion, which is excited amongst these principles, and which has great analogy with a fermentation, (whatever Boerhaave and his school may say of it, who did not admit of this analogy) is in some measure ordained or willed by Nature; that it is the means which she employs in order to destroy the animal organization and composition, when the animal matters, deprived of life, can no longer serve in the animated form, for the exercise and support of which those primitive matters had only been lent them according to the immutable laws established in the order of the universe; that Nature thus takes back those principles, which are no longer employed in the phenomena of life, and restores to other more simple combinations the portion of matter which constituted the bodies of the animals. Thus, by the admirable order which exists in the economy of Nature, the most complicated phenomena which represent during life the master-piece of organization the most numerous chemical phenomena,

are

are reduced after death into more ſimple compounds, almoſt all binary,—and by the aid of the putrid decompoſition, return into the claſs of the minerals, are thus reduced almoſt to the ſtate of elements, are diſſolved in the water, diffuſed in the earth, and ſerve for new combinations. Thus in ſtudying the properties and chemical characters of animal ſubſtances, we are led back to the ſimple and primitive ſubſtances with which we commenced the ſtudy of the natural ſubſtances. This effect, this tranſition, this circulation of ſubſtances, which had long ago been diſcerned by the ingenious Becher, were called by this chemiſt the circle of the eternal motion, *circulus æterni motus*.

17. Men have at all times availed themſelves of the phenomena and products of putrefaction, and have in ſome ſort derived the ſupport of their exiſtence from the very womb of death and deſtruction. The animal matters corrupted and reduced to the ſtate of mould are employed with much advantage as manures; in order to diminiſh their too hot and too nouriſhing properties, they are not diſtributed in the ground which is intended to be manured, until they are almoſt entirely deſtroyed. They are ſometimes alſo prepared by particular proceſſes of deſiccation and concentration, as is done in the vicinity of Paris with the filth of the privies, in order to convert it into a dry and very fecundating powder, which is called *poudrette*. In other places, by cauſing the animal matter to putrefy with vegetable

vegetable ſubſtances, or by moiſtening the latter, depoſited in dry layers and expoſed to decompoſition under ſheds with animal liquids, urine, the waters of kitchens, of ſhambles, &c. the production of nitre is accelerated, by means of the azote which thoſe liquids afford. In ſome manufactories animal ſubſtances, and eſpecially corrupted urine is employed for extracting with facility very abundant quantities of carbonate of ammonia. Laſtly, we might avail ourſelves of the diſcovery which I have made of the converſion of the bodies of animals into fat in ſtagnant waters or in moiſt earth, in order to prepare with offals that hitherto have been applied to no uſe, fats which would be uſeful in a great number of the arts. We are even aſſured that Engliſh induſtry has already availed itſelf of this diſcovery, and that a concrete oil is prepared in England by this mode of putrefaction.

18. There are ſome circumſtances which, by oppoſing more or leſs powerfully the putrid decompoſition of the animal matters, leave them only the poſſibility of being converted into ſubſtances of a different nature, and ſuſceptible of keeping for a long time in this ſtate. In this claſs are to be ranked; 1. dead bodies deſiccated by a dry and glowing atmoſphere, or by an arid and violently heated ſand ; 2. the natural mummies, and the mummies which art, at the ſuggeſtion of a religious ſentiment, or of a reſpectful attachment to the remains of beloved objects,

prepares

prepares by the aid of all the preſervative means and embalment; 3. bodies and their organs prepared by different anatomical means; 4. hair, ſilk, feathers, ſkins, prepared and preſerved in ſolid and durable textures; 5. ſmoaked, ſalted fleſh, which has become hard and as it were of a woody conſiſtence, in which ſtate it keeps for a long time without alteration; 6. bones, horn, ſcales, dried and converted into utenſils or machines of various forms and various utility; 7. bones impregnated with different minerals in the boſom of the earth, and eſpecially thoſe which are converted into turquoiſe. There is alſo reaſon to believe that a portion of the remains of animal ſubſtances, ſo abundant in the water of the ſea, and of large rivers, enters by their more or leſs advanced decompoſition, and by aſſuming the character of oily matter, into the formation of the bitumens. As to the petrified animal ſubſtances, which are generally ranked in the ſame ſeries with the preceding ſubſtances, theſe are either ſolids impregnated with calcareous diſpoſition, or merely moulds filled with ſiliceous matter.

THIRD ORDER OF FACTS

OF THE PROPERTIES OF PARTICULAR ANIMAL SUBSTANCES.

Article I.

Of the Comparison and the Classification of the different Animal Substances.

Section I.

Of the different Modes of their Classification.

1. IT is not sufficient to have considered the animal substances in general, and investigated the characters which distinguish them from the vegetable matters. This first inquiry ought only to be considered as an introduction to the history of these substances in particular. It ought to precede and to elucidate it; but it cannot be substituted in place of it; it has only the advantage of rendering more intelligible the examination of their properties, and diminishing the extent of the details which this examination would have required, if the exposition of the general properties of the animal matters had not determined their nature.

2. Though it may appear, at the first glance, a matter of indifference whether the chemical

hiſtory of the animal matters be treated in ſuch or ſuch an order, it is however neceſſary to decide in the choice of this order, and on this account it becomes neceſſary to indicate and compare with each other the different methods of claſſifying theſe ſubſtances. We know in the firſt place that they may be conſidered as a kind of immediate materials of animals, and that in this point of view it would be poſſible to divide or rather diſtribute them, as has been done with reſpect to theſe vegetable matters, into ſuch as are ſoluble in water, into oily, ſaline, ſolid and inſoluble ſubſtances. But this firſt kind of diviſion is very imperfect and very inaccurate, as it is far from comprehending all the ſubſtances which compoſe the bodies of animals.

3. The diviſion of theſe ſubſtances into liquids and ſolids is alſo inſufficient. Frequently the works on chemiſtry have followed the diviſion into recrementitious liquids, ſuch as the blood, the lymph; excrementitious, ſuch as the urine, &c. and excremento-recrementitious, as the bile, the ſperm, &c. We have no greater reaſon to be ſatisfied with this claſſification, which preſents nothing well fixed and accurate. Theſe matters might be arranged, according to their chemical nature, into four claſſes, according to the ſuperabundance of one or other of the principles which enter into their compoſition. Thus we ſhould have:

A. Hidrogenated or oily animal ſubſtances; ſuch as the fat, the cerumen, the bile.

B. Oxigenated

B. Oxigenated animal ſubſtances or oxides; the albumen, the lymph; in theſe would be comprehended the lymph, the water of the interior cavities, the cerebral pulp.

C. Carbonated animal ſubſtances; the gelatinous or mucous, comprehending the membranes, the aponeuroſes, the tendons.

D. The *azotated* animal ſubſtances, fibrous or fleſhy; ſuch as the muſcles, certain viſceral parenchymata.

E. The *acid* animal ſubſtances; the uric acid, the formic acid, the bombic, &c.

F. The *ſaline* aqueous animal ſubſtances; as the aqueous and the vitreous humor, the tears, the ſaliva.

G. The *phoſphated* animal ſubſtances, eſpecially thoſe in which the phoſphate of lime predominates; in this claſs would be placed the nails, the horns, the hair, the bones.

H. Finally, the *mixed* animal ſubſtances, containing ſeveral of the preceding materials; this laſt claſs would belong to the blood, the milk, the ſperm, the urine.

4. The chemical method which I have juſt ſketched would be beyond all contradiction the moſt perfect, the moſt exact, and that which ought to be preferred to all others, if the animal analyſis were more advanced, and if the comparative nature of the animal liquids and ſolids were better known. For not to mention that all theſe matters have not yet been ſufficiently analyzed to enable us to rank them in one or other of the eight claſſes

classes that have been indicated, I cannot present this division into eight classes, except as a very imperfect attempt, which, though not purely hypothetical, is not sufficiently well founded upon experience for it to be adopted and considered as proper to afford a right notion of the comparative nature of the different animal compounds. I give it here rather in order to show what chemistry may hope to attain in this respect, than as a true method of classification. Accordingly, I shall not adopt this method in the folowing articles, because not yet sufficiently exact.

5. The following is the order which the actual state of chemistry and of animal physics permits me at present to adopt. I shall divide the animal substances into three classes: in the first I shall rank those which are generally diffused throughout the whole body of animals; in the second, those which belong to some particular region or organ, and in the third those which are found only in some orders of animals, whilst the subjects of the two first are found generally in all. The animal matters generally diffused are either liquid, such as the blood, the lymph, the fat, the transpiration, the humor of the interior cavities of the synovia; or soft, as the cellular texture, the membranes, the tendons, the aponeuroses, the ligaments, the glandular texture, the muscles, the skin and the epidermis; or solid, as the horny texture of the hair, the cartilaginous texture, the osseous texture.

6. The fecond clafs of animal matters, belonging to the different regions of the bodies of animals, comprehends in four divifions :

A. The fubftances contained in the cranium.

B. Thofe which the cavities of the face prefent.

C. Thofe which are found in the thorax.

D. Thofe inclofed in the abdomen.

The matters belonging to the cranium are the cerebral pulp, the nervous fluid, the liquor of the ventricles of the brain, the pineal concretions.

Thofe of the face are the aqueous humour of the eye, the vitreous humour, the cryftalline humour, the tears, the nafal mucus, the mucus of the mouth, the mucus of the tonfils, the faliva, the falivary calculi, the tartar of the teeth, the cerumen.

To the matters belonging to the thorax are to be referred the tracheal and bronchial mucus, the gas proceeding from the lungs, the pulmonary concretions and the milk.

The fubftances contained in the abdomen comprehend the gaftric juice, the pancreatic juice, the bile and the biliary calculi, the inteftinal juice, the chyle, the excrements, the inteftinal gafes and the concretions of the inteftines, to which are to be added the liquor of the amnios, the fuperrenal liquor, the meconium, liquids peculiar to the fœtus, and finally, the urine, the urinary calculi, the juice of the proftata, and the fperm.

7. The

7. The third clafs of animal matters comprehends thofe which are peculiar to fome orders of animals, and which are frequently employed in the arts; and as thefe orders are feven in number, it is divided in the fame manner.

The firft divifion contains thofe which are particularly furnifhed by the mammalia, fuch as ivory, hart's horn, horn, wool, mufk, civet, ambergreafe and the bezoars.

The fecond divifion is referved for thofe which are obtained from the birds; namely, the eggs, the feathers, the dung, and the membrane of the ftomach.

The third prefents the product particular to the amphibia, the viper and its poifon, the fkinc, the lizard, the toad, the tortoife and its fhell.

The fourth is appropriated to fome productions peculiar to fifhes, ifing-glafs, fifh-oil, the fcales of the blay, and the bones of the head of feveral of thefe animals.

To the fifth I refer fome matters belonging to the teftacous fifh; the bones and the ink of the cuttle fifh, pearl and mother of pearl fhells.

In the fixth I place thofe which are extracted from infects and worms, the honey and the wax of bees, cantharides, wood-lice, ants, their acid and lac, the bread of the ant, filk, cochineal, kermes, crab's eyes, the lumbrici.

Finally, the order of Zoophytes affords four particular animal matters; namely, coralline, coral, the madrepore, and the fponge.

In order to exhibit the collective whole of this division of the animal substances, I here present a table in which the relation, the difference and the classification will appear at the first glance. It will there be seen that there are fifty-three different substances in the two first classes, and forty-one in the third; the importance of the fifty-three first obliges me to treat of them in a pretty considerable number of separate articles. As to those of the third, which present more or less resemblance with those of the two first classes, I shall content myself with giving an account of them in the seven articles which will comprehend the particular products formed by the seven orders of animals.

TABLE

Containing the Division and the Classification of the Animal Matters.

All the Animal Matters, considered in their mutual relations, may be divided into the three following Classes.

FIRST CLASS.

Animal Matters belonging to the whole Body.

Liquids.	Blood,	1
	Lymph,	2
	Fat,	3
	Transpiration,	4
	Humor of the internal cavities,	5
	Synovia,	6

	Cellular texture, -	7
	Membranous texture,	8
	Tendinous texture, -	9
	Aponeurotic texture,	10
oft parts. -	Ligamentous texture,	11
	Glandular texture, -	12
	Mufcular texture, -	13
	Cutaneous texture, -	14
	Epidermoid texture, -	15
	Hair, - - -	16
olids. -	Cartilage, - -	17
	Bone, - - -	18

SECOND CLASS.

Animal Matters belonging to fome particular Regions of the Body of Animals.

	Cerebral pulp, -	19
To the cranium.	Nervous fluid, -	20
	Liquor of the ventricles,	21
	Pineal concretions,	22
	Aqueous humor, -	23
	Vitreous humor, -	24
	Cryftalline humor, -	25
	Tears, - - -	26
	Nafal Mucus, - -	27
To the face.	Mucus of the Mouth,	28
	Mucus of the tonfils,	29
	Saliva, - - -	30
	Salivary calculi, -	31
	Tartar of the Teeth,	32
	Cerumen, - -	33

8. In order to exhibit the collective whole of this divifion of the animal fubftances, I here prefent a table in which the relation, the dif- ference and the claffification will appear at the firft glance. It will there be feen that there ar fifty-three different fubftances in the two fir claffes, and forty-one in the third; the impo tance of the fifty-three firft obliges me to tr of them in a pretty confiderable number feparate articles. As to thofe of the th which prefent more or lefs refemblance thofe of the two firft claffes, I fhall co myfelf with giving an account of them feven articles which will comprehend th ticular products formed by the feven or animals.

TABLE

Containing the Divifion and the Cla of the Animal Matters.

All the Animal Matters, confidered mutual relations, may be divid three following Claffes.

FIRST CLASS.

Animal Matters be... ing to th

To the thorax.	Tracheal and bronchial mucus,	34
	Gas of the lungs,	35
	Pulmonary concretions,	36
	Milk,	37
To the abdomen.	Gastric juice,	38
	Pancreatic juice,	39
	Bile,	40
	Biliary calculi,	41
	Intestinal juice,	42
	Chyle,	43
	Excrements,	44
	Gas of the intestines,	45
	Intestinal concretions,	46
	Liquor of the amnios,	47
	Superrenal liquor,	48
	Meconium,	49
	Urine,	50
	Urinary calculi,	51
	Juice of the prostata,	52
	Sperm,	53

THIRD

THIRD CLASS.

Animal Matters belonging to each of the Seven Orders of Animals in particular.

To the mammalia.	Ivory, - - -	54
	Hartſhorn, - -	55
	Horn, - - -	56
	Wool, - - -	57
	Muſk, - - -	58
	Civet, - - -	59
	Caſtor, - - -	60
	Ambergris, - -	61
	Spermaceti, - -	62
	Benzoar, - -	63
To the birds.	Eggs, - - -	64
	Feathers, - -	65
	Dung, - - -	66
	Membrane of the Stomach,	67
To the amphibia.	Viper, - - -	68
	Toad, - - -	69
	Skink, - -	70
	Lizard, - -	71
	Tortoiſe, - -	72
To the fiſhes.	Iſinglaſs, - - -	73
	Fiſh-oil, - - -	74
	Fiſh-ſcales, - -	75
	Fiſh-bones, - -	76

To

To the testacea.	Bones and ink of the cuttle-fish, - - - -	77
	Pearl and mother of pearl,	78
	Shells, - - - -	79
To the insects and worms.	Honey and wax, -	80
	Cantharides, - -	81
	Wood-lice, - -	82
	Ants, - - -	83
	Lack, - - -	84
	Ant-bread, -	85
	Silk, - - -	86
	Cochineal, - -	87
	Kermes, - -	88
	Crabs'-eyes, - -	89
	Lumbrici, - -	90
To the zoophytes.	Coralline, - -	91
	Coral, - - -	92
	Madrepores, - -	93
	Sponges, - - -	94

ARTICLE

ARTICLE II.

Of the Blood.

SECTION I.

History and Analysis of the Blood.

1. THE blood, this red and hot fluid contained in the arteries and the veins, neceſſary to life, moved inceſſantly by the circulation, moiſtening all the organs, conveying into them heat and motion, diſtributing nouriſhment, acting an important part in the animal economy, has always been conſidered as the principal object of the ſtudies and the reſearches of the anatomiſt, the phyſiologiſt, and the phyſician. The ſubject of many important inquiries, of a multitude of experiments, it is ſtill, notwithſtanding the ſtudies of the philoſophers and the numerous obſervations of the phyſicians, an inexplicable enigma; and though more advanced in the knowledge of its properties, modern phyſics are very far from the point at which they muſt arrive in order to explain its real influence upon the phenomena of life. Its effects appear to be extremely complicated, its uſes multiplied ad infinitum; we ſee it preſide in ſome meaſure over all the functions; reſpiration

tion acts especially upon it; the circulation is performed in order to convey it to all parts of the body; it is this which warms the whole animal system; it causes the heart to move; it is the common source of all the secretions; it nourishes all the organs; it affords the recrement as well as the excrement; it repairs the waste of all the parts; the lymph is one of its productions; the transpiration escapes from the cutaneous extremities of the canals which transmit it; it exists every where, it vivifies all the organic systems, the totality of which constitutes the animal machine; it must therefore offer to the philosopher the series of all the problems presented to him by the animal economy.

2. Accordingly the number of learned men who have occupied themselves with it is immense: some have examined its chemical properties; its mere quantity, its weight, its motion have been the object of much investigation, which is not even yet entirely terminated. Even its proportion is not known; and authors have varied amongst themselves from eight pounds to twenty-eight pounds for the quantity contained in the body of a man of the middle size. Some have said that it forms a fifth of the weight of the body, others only a twentieth. Some reckon it at a sixteenth, a fifteenth, &c. It is commonly believed to be distributed in such a manner that the veins contain nine and the arteries four parts. When we read in the learned work on physiology by Haller, the opinions

of

of Harvey, Allen, King, Lifter, Drelincourt, Hales, Moor, Siegel, Primerofe, Kiel, Lobb, Lower, Quefnay, F. Hoffmann, upon the proportion of the blood in the human body, we fee how many difficulties and uncertainties attend the precife knowledge of its moft fimple properties. If we alfo remark in the fame author what diverfity of opinion has prevailed in the fchools concerning the difference of colour and temperature of the arterial and the venous blood, a queftion which neverthelefs feems eafy to be folved by mere infpection or by fimple experiments; if we compare the celebrated names of Galen, Erafiftratus, Aretaeus, Harvey, Lower, Mayow, Schreiber, Willis, Swammerdam, Duverney, Verheyen, Helvetius, Michelotti, Lancifi, Sevérini, Chefelden, Hamburger, Martine, Pitcairn, Jurin, De Haen, who have not been able to folve thefe problems with accuracy, and who have left the refult uncertain, notwithftanding an affiduous labour of feveral ages: we fhall be able to conceive with what fetters the human underftanding has been fhackled in its progrefs relative to this important part of phyfiology.

3. Hence, many able and learned phyficians, deterred for a long time by this unfuccefsfulnefs of the phyfical fciences, and not trufting more to the experiments of the chemifts, have thought it neceffary to take a different courfe in order to appreciate the properties of the blood. Founded upon the phenomena which it prefents in the living animals, they have confidered

fidered it as an affemblage of all the animal liquors, as a refervoir of all thofe materials, a folution of all the folid parts, a fort of liquid flefh, of plaftic animal mucilage, hot, boiling, moved in torrents, tending to all parts of the body, communicating with all, affuming a particular nature in each organ and even in the vicinity of each of them, diftributing into all their cells the materials which muft ferve for their reparation, remaining fluid only by the effect of motion, precipitating fibres already become folid by a flight agitation, difpofed to affume the ftate of concrete mafs when its motion is retarded, animated by a particular or vital power which difappears in death, and which can no longer be perceived in it when it is feparated from the living animals. This feries of notions they have called the medicinal analyfis of the blood. But whatever ingenuity Bordeu has difplayed in the expofition of thefe ideas, we find in them neither precifion, nor accuracy, nor pofitive knowledge; but merely vague notions, the fruits of an active imagination, perhaps liable to the fame reproach which he caft upon the chemifts.

4. Notwithftanding the little confidence which the phyficians (indeed amongft thofe who though otherwife poffeffed of much learning and talents had not acquired a fufficient ftock of chemical knowledge) have teftified for the examination of the blood by the means of this fcience, a great number of chemifts, alfo belong-

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ng to the clafs of the phyficians, and confequently competent to balance the opinion of the firft, have occupied themfelves with the chemical analyfis of the blood.

After the firft ftill very inaccurate attempts of Barbatus and Bohnius in the feventeenth century, after the difputes of Vieuffens, of Willis, &c. whether to admit or reject the prefence of a pretended acid in the blood; Ruyfch treated experimentally the concrefcibility of the blood, the art of obtaining from it fibres, textures, membranes; Lewenhock and Hartfoeker inveftigated its nature with the microfcope, and defcribed in it a compound globulous ftructure, of which Boerhaave has made an ingenious ufe, though it is nothing more than a fort of microfcopic fiction.

Hales wrote learnedly upon its analyfis by fire, and upon the elaftic fluid difengaged from it by this agent.

Lemery found it to contain iron ready formed, the proportion of which was determined by Menghini.

Hoffmann was one of the firft who defcribed the chemical characters of its different parts feparated fpontaneoufly.

Langrifh, Cheyne, Swencke, have given analyfes of it that are almoft complete for the time in which they wrote.

Gaubius examined it after Boerhaave with much greater accuracy than his predeceffor.

Rouelle

Rouelle the younger first showed with precision the salts that are contained in it.

G. Hewson described several of its properties with sagacity.

Bucquet, immediately after Rouelle, particularly studied the chemical characters of the coagulum and of the fibrous part.

Dehaen has shown that its coagulation, its serum, its buffy coat, vary according to the circumstances of its extraction in venesetion.

Cygna did all in his power to discover the cause of its rutilation by the air, which has since been placed out of doubt by the experiments of Lavoisier, Menzies and Godwyn.

Crawford has determined the difference of the specific heat of the arterial and of the venous blood.

Citizens Deyeux and Parmentier have examined with much attention the different materials of the blood, the serum, the fibre, the coagulum, and some of its morbid alterations.

I have likewise occupied myself with it, at different times, during fifteen years past; I have ascertained the presence of the gelatin in it, the action of a violent fire in open vessels, its difference in the fœtus, &c.

The rapid sketch which I have just presented is sufficient to prove that much labour has been bestowed upon the nature of the blood; I must terminate it by observing that though chemistry has not yet resolved all the problems which this fluid presents to it, it has at least shown the path

path that muſt be followed in order to find their ſolution, as the following details will prove.

Section II.

Of the Entire Blood.

1. THE blood of man, and that of the bullock which much reſembles it, and which has been moſt frequently ſubjected to chemical analyſis, as it is procured with great facility, is a liquid of a beautiful purple-red colour, of a conſiſtence a little thick, gluey and viſcous, ſoft and, as it were, ſaponaceous to the touch, of a particular faint odour, and of a ſweetiſh and ſaline taſte. Its temperature is between 29 and 32 degrees centigrade. Phyſiologiſts have differed from each other with reſpect to the ſpecific gravity which they have attributed to it. They have found its relation to the gravity of water as 1053 or 1126 to 1000. It has been ſaid that, when viewed with the microſcope, it is a compound of red globules ſwimming in a tranſparent liquid, and that the red globules are formed of ſeveral other yellow globules united together; that theſe globules are divided and broken in the ſmall veſſels, and thus give riſe to liquids more and more pale, leſs and leſs coloured, which are found in the orders of veſſels more and more attenuated. Theſe globules were deſcribed as capable of

of being compreſſed, elongated, flattening, and paſſing through the animal ſtrainers. Modern phyſiologiſts have rejected all theſe ideas as chemerical. What is true, ſays Haller in the hiſtory of theſe globules, is that we actually ſee ſuch in the blood with the aid of the microſcope; but the yellow ones which are alſo ſometimes ſeen in it are not ſmaller than the red, they are not diviſions of them, they appear only in debilitated animals; they ſwim in a tranſparent and almoſt inviſible ſerum; the red globules have neither been ſeen to break nor to re-unite, they are not converted into ſerum by their pretended diviſion, of which in fact (as we ſhall ſee hereafter) they have neither the characters nor the intimate nature.

6. The entire blood, which we ought to examine before its particular parts, when expoſed to a mild temperature and which does not exceed 100 degrees of the centigradel thermometer, diffuſes but very little vapour in the air, thickens and coagulates, aſſumes a brown colour much reſembling that of the liver of animals, and gradually dries if we agitate it, ſo as to be converted into an almoſt black powder, greaſy to the touch, and which keeps without alteration in well cloſed veſſels; in the air it becomes a little moiſt and covered with an efflorefcence of carbonate of ſoda. The coagulum of the blood dried in the air becomes ſenſibly attractable by the magnet; heated more violently in a crucible, it ſoftens, becomes as it were oily, melts,

melts, swells, inflames and is reduced into coal, after having exhaled a very fetid smell. What is disengaged during this strong and decomposing action of the open fire presents a series of products which I have carefully described; first, ammoniacal water; secondly, a white and very pungent vapour of carbonate of ammonia, and soon a yellowish thick smoke very fetid, which is manifestly oily and inflammable; afterwards Prussic acid recognizable by its smell of bitter almonds; then phosphoric acid, announced by some flames emitted from the coally and red-hot matter; finally, carbonate of soda. There remains in the crucible a mixture of oxide of iron of a blackish or brown-black colour, granulated and crystallized; of carbon combined with a little iron, and almost in the state of carburet of this metal; finally, of phosphate of lime and muriate of soda. We see that in this operation the constituent principles of the blood are separated almost all into binary compounds, if we except the oil and the Prussic acid. It is to be observed that when the blood is boiled in a basin of copper, this liquid dissolves enough of the metal to yield, on calcining it with alkali, cupreous Prussiate, even in abundance.

7. When instead of treating the blood by the fire in open vessels, we distil it in close apparatusses, with a mild heat, especially with that of the water bath, it affords much water, which has a faint smell, and putrefies and becomes fetid when kept; the blood at the same time

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is found coagulated into a brown ſubſtance and even dried. If we afterwards diſtil it in a retort, by a well managed fire till the bottom of the retort of porcelain, in which this diſtillation ought to be performed, is red-hot, we obtain fetid water charged with carbonate and zoonate of ammonia, beſides an ammoniacal ſoap which gives it a red-brown colour; an oil, at firſt red and light, afterwards brown, blackiſh, thick and almoſt concrete, very fetid, and which, before it condenſes, fills the receivers with a thick white vapour of cryſtallized carbonate of ammonia; and laſtly, carbonated and ſulphurated hidrogen gaſes. There remains in the retort a ſpongy coal, of a brilliant and as it were metallic appearance, adhering very ſtrongly to the veſſel, very difficult to be incinerated, in which are found by analyſis, beſides the carbon united with a little iron, phoſphate, muriate, and carbonate of ſoda, phoſphate of iron, and phoſphate of lime. Though this diſtillation by a naked and violent fire, the only means of analyſing the blood that was formerly poſſeſſed, does not afford the real principles of the blood as was formerly believed, it correſponds with what has already been indicated in the hiſtory of the general characters of animal ſubſtances, and like the treatment by the open fire, it ſhows us what are in general the primitive principles of the blood.

8. Blood, expoſed to the air, after it has 'rawn out of its veſſels, fixes or concretes

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more or lefs fpeedily; it forms, either an almoft folid mafs, red without and black within, or a fubftance as it were gelatinous, tremulous, refembling currant-jelly, according to the age and the ftrength of the individuals from whom it is taken. It is this fpontaneous coagulation which caufed the ancients to adopt the notion of its plaftic power, and to confider the blood as a kind of liquid flefh. Some hours after this fpontaneous concretion into a fingle homogeneous mafs, the blood fhrinks, condenfes, and there feparates from it a liquid of a greenifh white colour, which is called the ferum of the blood. Though this double effect takes place in clofe veffels as well as in the air, the latter favours its production; its mere contact converts the black colour of the coagulum into a brilliant red; foon, and efpecially when the atmofphere exceeds twelve degrees or the temperate heat, the blood foftens, melts, diffolves, exhales a fmell, at firft faint, afterwards fetid, and at laft is completely decompofed by putrefying. The moifture of the atmofphere accelerates this putrefaction, where s great drynefs combined with a high elevation of temperature in the air, dries this liquid and thickens it, inftead of giving rife to the feptic decompofition like the preceding; the contact of oxigen gas renders the colour of the blood brilliant; azotic and hidrogen gas, on the contrary render it brown or violet; fulphurated hidrogen gas blackens it.

N 2 9. The

9. The blood is entirely ſoluble in water when it is perfectly liquid; when it is coagulated the water diſſolves only its red part and leaves the fibrous, ſolid and white part of the coagulum inſulated: this is the means which is put in practice in order to ſeparate theſe two ſubſtances, and form the commencement of an analyſis of the blood both immediate and ſimple. If we throw blood into water heated above 45 degrees of the centigrade thermometer, this liquid preſents a number of floating pellicles or membranes; we ſee this effect in blood-letting at the foot. Above the temperature here indicated in the water into which it is thrown, the blood is entirely coagulated into brown flakes which condenſe and ſhrink together. Long continued maceration of the blood in water favours its putrid decompoſition, the colouring matter is precipitated and becomes darker, and the ſolid ſubſtance of the coagulum at laſt aſſumes the character of adipocerous fat. Sometimes two parts of water and one part of blood having been coagulated by fire, the liquor ſeparated from the coagulum, evaporated ſlowly, yields a bilious extract: it was in this manner that I demonſtrated the preſence of bile in the blood in 1790.

10. The acids when mixed with fluid blood coagulate and decompoſe it, rendering its colour darker, and more or leſs brown when they are concentrated. The concentrated ſulphuric acid renders it very brown and reduces it to coal. The nitric acid, whilſt it coagulates it, diſen-

gages

gages from it much azotic gas, and converts its ſubſtance into carbonic acid, oxalic acid, and fat matter; the muriatic coagulates it without ſenſibly altering its colour; the oxigenated muriatic acid turns it black like ink. The vegetable acids only thicken it; the acetic acid is the only one of them which effects its coagulation. The cauſtic alkalis, on the contrary, liquefy and diſſolve the blood even when coagulated by the acids; if we mix them with blood recently drawn and which has not yet coagulated, they prevent its coagulation. It has already been ſeen how the alkalis, heated ſtrongly with this liquid, become in part ſaturated with Pruſſic acid.

11. Many ſalts have been mixed with the blood, and their effect has in general been found to correſpond by the antiſeptic property and the ſoftening or liquefaction which they effect, as well as by the obſtacle which they oppoſe to its coagulation. At one time this effect of the ſalts and of the ſaline ſolutions upon the blood was conſidered as an indication of their medicinal virtue; but this notion was ſoon diſcovered to be a real error, dangerous to the art of healing. The earthy ſalts in general are decompoſed by the blood by means of the ſoda which it contains.

The metallic oxides have no ſenſible action upon the blood, except thoſe which by eaſily yielding their oxigen coagulate it. Almoſt all the metallic ſolutions precipitate and coagulate the blood;

blood; they act especially upon its albuminous part; it is almost superfluous here to add that these two classes of bodies, the alkaline and the metallic salts, preserve the blood and defend it against putrefaction.

12. Most of the immediate materials of vegetables, and even of the entire plants, produce this latter effect upon the blood and act upon it as antiputrescent; it is especially in sugar, the volatile oils, camphor, the resins and the balsams, that we find this property. The solutions of gum and of starch coagulate it.

Tannin precipitates the blood abundantly; gallin and the pure gallic acid blacken it and form in it an atramentous deposition, which without any other experiment is sufficient to indicate the presence of iron in it. We may obtain this precipitate by diluting the blood with much water. At the same time the astringent property of the gallic acid and of the extract which accompanies it in the gall-nut, thickens, condenses and even hardens the solid matter of the blood; the same effect is observed in all the astringent vegetable substances, particularly in Peruvian bark, Simarouba, the peel of the pomgranate, sumac, the outer shell of the wall-nut, tea, &c.

Alcohol, poured upon the blood, also effects its coagulation, but it precipitates it only in small flakes, which water separates and dilutes so as almost to dissolve them.

13. The

13. The blood, like all the other particular animal matters, has its mode and peculiar phenomena of putrefaction. Its colour grows darker and brown, it loses its consistence, its odour becomes insufferably fetid; there are separated from it a great number of membranous flakes, brown pellicles which gradually grow blacker; a considerable quantity of ammonia and carbonic acid gas is disengaged from it. It requires a very long time before it entirely loses its form, and characters of blood, before it becomes a solid, thick extractiform matter, and especially before it is reduced to a species of mould. There are then found in it nearly the same materials as in the coal which remains after its distillation or combustion, except that this residuum retains a greasy or unctuous feel, which announces in its alteration a well-marked production of fat matter.

Section III.

Of the Separation and Classification of the immediate Materials of the Blood.

14. THOUGH all the chemical characters of the entire blood are not without interest, they are however not so well marked or so important as those which belong to its immediate elements, to the different materials which separate sponta-

neously

[illegible] from it. It is known that this liquid, when left to itself as it issues out of the veins or the arteries of the living animal, presents, whilst it is hot and fluid, an odorous exhalation which has been considered as one of its principles; that it soon coagulates or concretes into a tremulous gelatiniform mass, which condenses, shrinks, gradually approaches in its parts, and expresses from itself a liquid of a yellowish white colour and transparent; that it then resembles a kind of curd, a floating red cake, which has been called *cruor*, *clot*, or *insula rubra*, that this formation does not take place in the same manner when the blood has been violently agitated; that by this agitation, which is frequently practised in the shambles, there is separated from the blood a remarkable quantity of fibrous matter, solid, whitish, and ropy, as it were, which attaches itself to the stick which is employed to stir it; that when the serum or the white part has been separated from the coagulum, this, washed with water thrown in a stream upon its surface, is separated into two matters, the one of a red-colour, dissolved in the water with which it has been washed; this is the colouring matter of the blood; the other, solid, white, filamentous, which is called fibre, or fibrine. Thus there are five matters to be examined in particular; namely, the odorous exhalation, the serum, the coagulum, the colouring matter and the fibrous substance. I shall first remark that

immediate materials of the blood, when

once

once ſeparated from each other, or even two of them, the coagulum and the ſerum, inſulated ſpontaneouſly, cannot again be united, or combined ſo as again to form blood, and that when once the connection is broken between them by their ſeparation from the living body and the ceſſation of the vital motion, their primitive compoſition can no more be made to re-appear.

Section IV.

Of the Odorous Exhalation of the Blood.

15. I DISTINGUISH amongſt the principles belonging to the blood the odorous exhalation; in order to conform to the opinion of the moſt celebrated phyſiologiſts who have conſidered it as one of the moſt important elements of this liquid, and who have attributed to it very powerful effects in the animal economy. Some modern philoſophers have thought that this principle was a particular gas, and it is according to this idea that Citizens Deyeux and Parmentier have made experiments upon this exhalation in their new analyſis of the blood. It reſults from their experiments that this principle cannot be obtained inſulated in the form of gas, that when it was condenſed in a bottle of which the blood, which had been put in quite hot, filled one part, and of which the portion

full

full of air received this odorous body: this air did not extinguiſh the tapers that were immerſed in it; that it did not precipitate lime water; that it was however ſufficiently ſtrongly impregnated with the ſmell of blood to communicate it to water by agitation, to diffuſe after ſome time a fetid ſmell, to extinguiſh theſe lighted tapers, without however containing ammonia; that it was then a little leſs pure by the teſt of the eudiometer; that the odorous water extracted from the blood by diſtillation on the water bath, and which yielded nothing to the re-agents, putrefied, depoſited flakes, and turned the ſyrup of violets green; that when it was heated in this ſtate it afforded a ſediment that burned upon the coals, with the ſmell of the retort. Blood, diſtilled with alcohol preſented to them, in its volatile product, the very diſtinguiſhable odour which it emits when it has been poured into water; yet this odorous alcohol ſhowed no effect upon the re-agents. The chemiſts whom I have quoted thought themſelves authorized to conclude from theſe experiments, that the aroma of the blood is the moſt alterable principle, and that which firſt changes the ſtate of this liquid by eſcaping in the volatile form. In the phenomena that have been indicated I can ſee only a ſmall portion of the entire matter of the blood raiſed in vapour with the water, and I find no relation between the experiments relative to this vapour and the uſes that have been attributed to it. It has

been

been erroneoufly believed that the froth formed by the blood, fpouting out and falling from an eminence, was a proof of this gas: it is only air confined by the vifcidity of this liquid.

16 Though I do not admit a particular principle of the odour of the blood; it is neverthelefs of importance to know that this odour is one of the moft marked characters, one of the moft ftriking differences which are found in this liquid, confidered under different circumftances. The odour of the blood is very feeble in infants and in females; it becomes very ftrong at the age of puberty, as foon as the feminal fluid is formed in abundance and collected in its refervoirs; it has then fomething ftrong, acrid and even fetid. The blood of eunuchs is deprived of it, as well as that of old men; accordingly fome phyfiologifts have believed that the fmell of the blood and of the flefh, to which it communicates itfelf, is owing to the fpermatic fluid volatillized, diffufed in the cellular texture of the body, and penetrating into all its regions. Bordeu has ingenioufly treated this remarkable fubject as one of the fymptoms of the fpermatic cachexy, in his medicinal analyfis of the blood.

Section V.

Of the Serum of the Blood.

17. THE name of ſerum, water of the blood, and the improper one of lymph, are given to the liquid which ſeparates from the coagulated blood when it has not been agitated; it is the thinneſt and the lighteſt liquid contained between the interſtices of the coagulum, and expreſſed out of its cavities by the approximation and attraction of the molecules of the cruor. The ſerum is of a greeniſh yellow colour, of a ſaline and inſipid taſte, of a conſiſtence ſufficiently viſcid to glue the ſkin ſlightly, when rubbed between the fingers. Its proportion is very variable and cannot be fixed; however, ſeveral phyſiologiſts have attempted to determine its quantity. Hamberger ſuppoſed it to conſtitute a third of the weight of the blood; Schwenke believed it to conſtitute two thirds; Drelincourt and Boyle admitted it to be one half; Queſnay three quarters; Vieuſſens gave for the red part 0,62, and for the ſerum 0,38; Homberg indicated five parts for the ſerum, and three for the red matter. According to Robinſon, it is much more abundant in young animals; the cruor or the red part augments with age, and a period arrives in which the

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proportion of the ſerum deſcends to one third of the red ſubſtance. It is alſo ſaid that the blood contains more ſerum after meals, and that when the individual is faſting it has much more ſolid matter. Lower and Haller attributed this effect to the chyle poured in by digeſtion. Muſchenbroeck, Martyne, Schwenke, Jurin, indicate the ſpecific weight of the ſerum compared with that of water as 1027 to 1000.

18. The ſerum expoſed to the fire coagulates or hardens, and becomes opaque like white of egg. This property is one of the characters by which it is eminently diſtinguiſhed; it is attributed to a particular matter eaſily recognizable by that circumſtance, and which is called *albumen*, becauſe it is the ſame which exiſts in the white egg called *albumen*. When it is gently heated in this ſtate of coction or coagulation, the coagulated and ſolid ſubſtance becomes hard, brittle, and ſemi-tranſparent like horn. Heated by fire in the retort, it affords ammonia, carbonate of ammonia, fetid oil, ſulphurated hidrogen gas, and a coal in which are found muriate, phoſphate, and carbonate of ſoda. The ſerous liquor of the blood is alſo capable of turning the colour of violets green, which is likewiſe a property which it has in common with the freſheſt white of egg. According to theſe experiments, however ſimple they may be, the ſerum of the blood is conſidered as a combination of an albuminous matter with ſoda; a combination in which the alkali

alkali united with the albumen, preserves its properties as it does in soap.

19. The serum turns the syrup of violets green, and the tincture of curcuma brown; it constantly exhibits the alkaline properties; exposed to the fire, it becomes concrete at the temperature of seventy-five degrees of the centigradel thermometer. This phenomenon, which was first observed by Harvey, the immortal author of the discovery of the circulation of the blood, is one of the most important which this animal substance presents: every one knows it in the white of egg; but it differs sensibly in the serum, as this liquid, being not so thick as white of egg, neither acquires the same solidity, nor the same opaque whiteness in its concretion. Though it forms a mass, it is always tremulous; it is found filled with bubbles, and manifestly formed of two different substances when it has cooled after its coagulation; its colour is a pearl-grey, it retains a semi-transparency; there is observed in it a softer portion, less opaque, frequently interposed between the particles and in the middle of the most opaque grey mass, sometimes collected at its surface, especially when it has been coagulated slowly and by a well-managed fire. When this portion does not show itself in this manner, which is the case when the serum is too liquid and too aqueous, the part which does not become fixed, when evaporated and left to cool, concretes into a real

real jelly. The portion which, by the action of the fire, is congealed, and becomes opaque and insoluble, is called albumen, from its analogy with the white of egg; the more transparent matter which becomes fixed especially by cooling, and which is soluble in water, is termed gelatin. Chemists were unacquainted with its existence in the serum of the blood, till I discovered it to be present in it, in 1790. We shall soon see from whence the coagulation of the serous albumen proceeds: it is necessary here to observe, that its concretion by heat always leaves it viscid, gluey, tenacious, and not brittle, smooth and dry in its fracture, as we see in the white of egg hardened by the action of fire.

20. If we treat the serum of the blood by distillation on the water bath, it affords a very large quantity of water slightly odorous, in every respect similar to that which is obtained from the blood, and like it putrescible. The serum coagulated and dried in this operation is brittle, hard, almost transparent, and of a yellow, orange, or brown colour: when strongly heated and distilled in a retort, it affords water and fetid oil, carbonate of ammonia, partly concrete, and partly dissolved in water, a little Prussiate and zoonate of ammonia, carbonated and sulphurated hidrogen gas, and carbonic acid gas. There remains a very voluminous light coal, difficult to be incinerated, which contains, with the carbon, muriates of soda and of potash,

ash, phosphate of lime, and carbonate of soda. No metallic oxides are found in it. When the coagulated serum is slowly heated in a retort, sulphur is sometimes separated from it, which Citizen Deyeux has also obtained from white of egg. A plate of silver immersed in it becomes black, whilst it is made to coagulate by the action of fire.

21. When exposed to the air, the serum of the blood absorbs oxigen from it, and exhales carbon into it, whereby a part of the atmospheric oxigen gas is converted into carbonic acid gas; in proportion as this liquid absorbs the atmospheric oxigen, it becomes more concrescible, more capable of being rendered solid by the action of the fire; it frequently becomes turbid, and deposits flakes already spontaneously concreted. It is for the same reason that white of egg which has been kept exposed to the air boils quicker than that which is fresh, that the serum of the blood of animals which respire is more concrescible than that of animals which respire little: I have thence concluded that the concrescibility, the plastic nature of this humor, proceed from the fixation or the intimate combination of oxigen. Of this we shall soon see other proofs. To this property of absorbing air, the serum owes that of frothing by agitation which it possesses. Long exposure to the air favours the spontaneous decomposition of this humor, and accelerates its putrefaction; it then exhales a very fetid smell, acquires a brown

a brown colour, becomes ammoniacal, and at laſt leaves a kind of dark-coloured reſidue, which remains for a long time fetid, preceded by a ſoft or entirely melted putrilage, which exhales a great ſtench. The ſepticity of this liquor proceeds ſo rapidly, that Bucquet could not determine whether it paſſed into the acid ſtate before it acquired the ammoniacal character. It is preſerved from putrefaction by all the means indicated in one of the preceding articles.

22. The ſerum of the blood unites with water eaſily, and in all proportions. The aërated water renders it ſlightly turbid, and a ſmall portion of it concrete. Boiled water does not produce the ſame effect, but remains tranſparent. When we diſſolve ſerum in ten or twelve parts of water, the liquor which reſults from it reſembles milk, according to the obſervation of Bucquet: it is white and opaque; it becomes rarefied, and riſes over the fire like that liquid; it yields by evaporation membraniform pellicles; it is coagulable by the acids, &c. &c. The conſiſtent and viſcous ſerum has the property of rendering two or three parts of water ſolid; for notwithſtanding this addition, it is rendered concrete by heat, and the water does not ſeparate from it, on account of the adheſion which it contracts with it. When this humour is diluted with five or ſix parts of water, and heated to ebullition ſo as to render the whole of the albuminous part concrete, the liquid that

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is ſeparated from it, when properly evaporated, affords afterwards by cooling, a jelly which becomes fixed. It was in this manner that I diſcovered the gelatin in the ſerum of the blood.

23. The metallic oxides do not unite with the ſerum in general; but thoſe which ſuffer their oxigen to be eaſily diſengaged from them, and which adhere but feebly with it, ſuch particularly as the red oxide of mercury triturated for ſome time with the ſerum, paſs again into the metallic ſtate, or approach to it more or leſs; at the ſame time the ſerous albumen becomes thick, opaque, and more or leſs coagulated. This experiment, which I deſcribed in 1790, proves that oxigen favours the concretion of the albumen, and that, as I have already announced, No. 18, the plaſtic property proceeds from the fixation of this principle; ſo that the concreted albumen is a real oxide. When the metallic oxides are highly oxigenated, and adhere very little with the oxigen, their action goes ſo far as to burn and reduce the ſerum to coal. By this circumſtance is explained the catheretic or even cauſtic effect of the metallic poiſons. It is however to be remarked, that this effect of the oxides of mercury, of their diſoxidation by the ſerous albumen, has a boundary, that it extends only ſo far as to cauſe them to paſs into the ſtate of black oxide, and that in this manner we may conceive why running mercury triturated with ſerum is extinguiſhed or reduced to the ſtate of

black oxide. In theſe two experiments compared with each other, we ſee a new proof of the different attraction of different portions of oxigen for the ſame metal. The firſt portion is taken by the mercury from the albumen, and the ſecond by the albumen from the oxide of mercury.

24. All the acids coagulate the ſerum, ſeparate from it the albumen in flakes more or leſs denſe, and of a greyiſh-white colour, the more ſolid in proportion as the acids are more concentrated. All of them, after having produced this coagulation, remain in the ſuper-natant liquor, in part ſaturated with ſoda, which they have taken from the ſerum: ſome chemiſts have believed, on account of this effect, that the ſoda was combined with the albumen as it were in a kind of ſoap, and that it was this that rendered it ſoluble in water. Rouelle the younger conſidered it, however, as being almoſt entirely inſulated. Bucquet, on the contrary, maintained that it was intimately combined with it, and that even the acids took away only a part of the ſoda of the ſerum; in proof of which he adduced that the coagulum formed in this liquor by acid in great exceſs, contained ſtill carbonate of ſoda after its combuſtion and incineration: this fact however requires to be confirmed. The coagulation of the ſerum by the acids is prevented by mixing with it, before it is added to the latter, a certain quantity of the ſolution of an alkaline carbonate; the

effervefcence which the acid that has been added produces carrying off the caloric in order to reduce the carbonic acid to the ftate of gas, no longer permits the mixture to become heated, and confequently guards the albumen againft the coagulation which it experiences without this addition.

25. Befides this general effect of the acids upon the ferum, each of them has fome peculiar to itfelf. The concentrated fulphuric acid turns it brown, and reduces it to coal; that which is diluted with water only coagulates and preferves it. The nitric difengages from this humour coagulated by fire, azotic gas, carbonic acid gas, Pruffic acid gas, and converts the reft into oxalic acid and fat. The fuming muriatic acid communicates a violet colour to the ferum, or coagulates it; by a long contact it becomes faturated with ammonia by decompofing this fubftance. All the other acids precipitate, coagulate, and preferve the ferum; ammonia eafily diffolves the albuminous coagulum formed in the ferum by their action.

26. All the earthy and alkaline bafes have actions more or lefs marked upon the ferum of the blood. The folutions of barites, of ftrontian, and of lime, precipitate this liquor; the precipitate is a real infoluble phofphate. The leys of fixed alkalis render the ferum more liquid; with the aid of heat they diffolve its coagulated albumen. The cauftic and dry pot-afh or foda, triturated with this liquor when thick

thick or boiled, ſuddenly diſengage ammonia from it, and diſſolve a part of the remainder. When theſe alkalis are heated and calcined with coagulated ſerum, the ley which is made of the reſidue of this coagulation, is found to contain Pruſſic acid, and precipitates iron in the blue ſtate. When the ſerum is boiled with an alkaline ley much diluted, and when this liquor is filtrated, the weak acids poured into it diſengage from it a very perceptible ſmell of ſulphurated hidrogen gas: this is one of the proofs which Citizen Deyeux has adduced to prove the preſence of ſulphur in the ſerum of blood, which is beſides manifeſted by other experiments that have already been indicated.

27. Serum combines with moſt of the ſaline ſolutions, without experiencing any alteration from them, except being preſerved and defended againſt putrefaction. It however decompoſes the calcareous ſalts by virtue of the ſoda and phoſphate of ſoda which it contains; the precipitate which it forms in it is a compound of lime and phoſphate of lime. The ſoluble baritic ſalts produce no effect upon it. Thoſe of ſtrontian are decompoſed, and their baſe is precipitated by ſoda. The ſame is the caſe with the ſalts of alumine, of zircon, and of glucine. The ſoda of this liquor ſeparates alſo the ammonia from the ammoniacal ſalts, and this volatile alkali ſeizes the albumen of the ſerum, which it diſſolves, or at leaſt renders more fluid.

28. I have

28. I have already ſaid, that the metallic oxides thicken and coagulate the albumen; and it is evident that, combined with the acids, they muſt produce this effect in a ſtill more powerful manner, as they are aided by the latter, which themſelves alſo produce it in a very marked manner. When we pour a metallic ſolution into the ſerum of the blood, there is ſuddenly produced in it a thick and coagulated precipitate, formed by the metallic oxide and albumen. But beſides this, the muriates, the phoſphates, and the ſoda which it contains, occaſion another kind of decompoſition in the metallic ſalts: ſo that the precipitate which they form in them is generally compoſed of four ſubſtances, the oxide ſeparated by the ſoda, the oxide united with the albumen, a muriate and a phoſphate of the ſame oxide. Such eſpecially is the effect of the nitric ſolutions of the white metals, of mercury, of lead, and of ſilver; the latter alſo ſhows the ſulphur in it by the black ſtreaks which it forms in it. Theſe precipitates, eſpecially that of mercury aſſume a roſe or fleſh-coloured tinge. The ſerum treated in this manner has become unalterable and imputreſcible. There are ſome metallic ſalts which are capable of uniting with the ſerum without decompoſition: ſuch eſpecially is the phoſphate of iron with exceſs of oxide, which colours it red.

29. Some vegetable matters act in a particular manner upon the ſerum. Alcohol coagulates

it and precipitates it in ſmall whitiſh flakes, which eaſily divide in water and remain ſo well ſuſpended in it that we might conſider it as diſſolved. Bucquet had even announced that the coagulum formed by alcohol was entirely ſoluble in water, and diſappeared when a ſufficient quantity of this liquid was added. The fixed oils are rendered miſcible with water by the ſerum of blood. The volatile oils, camphor, the reſins, the balſams, and the gum-reſins, preſerve this liquid, and prevent its putrid decompoſition. Tannin is of all the immediate materials of vegetables that which has the moſt remarkable action upon the ſerum of the blood: it precipitates itſelf abundantly into a yellow, gold-coloured, ropy, and pitchy ſubſtance, inſoluble in water, which dries and becomes brittle in the air, which has no longer any kind of alterability, and which reſembles leather too much tanned and become dry, hard and brittle, by exceſſive tanning. The gelatin and the albumen are equally precipitable by tannin, but the firſt is more eaſily dried than the ſecond; and though the diſtinctive characters of theſe two tanned ſubſtances have not yet been determined, it is no leſs certain that they preſent reciprocal differences which may hereafter ſerve to diſtinguiſh the one from the other, perhaps even to ſeparate them, and eſtimate their proportion.

30. All the facts relative to the properties of the ſerum of the blood prove, that this liquid is

a kind

a kind of animal mucilage, compoſed of albumen and gelatin in different proportions, diſſolved in a variable quantity of water, conſtantly combined with pure ſoda, which is united with the albumen almoſt in a ſaponaceous combination: we alſo find in it muriate of ſoda, phoſphate of ſoda, ammoniacal phoſphate, and phoſphate of lime. The latter appear to be not eſſential to its combination: not only their proportion varies; but they may exiſt or not exiſt, be in the number indicated, admit of the abſence of ſome of them, or the ſimultaneous preſence of a greater number. For example, we may find in it muriate of pot-aſh, phoſphate of magneſia, or ammoniaco-magneſian phoſphate, &c. without the albuminous alkaline and gelatinous matter of the ſerum of the blood changing or preſenting properties foreign to thoſe which characterize it.

SECTION V.

Of the Coagulum or Cruor.

31. WHEN the blood, after ſeveral hours coagulation, has afforded all the ſerum that can run, and be expreſſed from it, the coagulated, half ſolid, and contracted ſubſtance which ſwims in the middle, is known by the name of

of *coagulatum*, *placenta*, *insula*. This mass has been called *cruor* before the means of separating it into the two different matters which constitute it, had been discovered.

It appears that the differences of proportion between the serum and the cruor, that have been admitted by the different authors, are owing to its variable quantity. Wieussens estimated it at 0,62, and gave only 0,38 to the serum; Homberg gave five parts to the latter and three to the cruor; Schwenk reckoned the serum at two-thirds, and the cruor at one-third; Quesnay the serum at three-fourths, and the cruor at one-fourth; Senac the serum at four-fifths, thee cruor at one-fifth; Schwenk admitted it to be only one-eighth. Boerhaave adopted the latter proportion. In general physiologists, according to Haller, think that the cruor increases as the individual advances in years; that the serum predominates in young animals; that those which are vigorous afford more cruor, and that when they are debilitated or badly fed, this matter diminishes in them. Nevertheless it results from this comparison of opinions and facts, that the cruor or the substance of the coagulum is in general less abundant than that of the serum. It is also to be observed that the proportion of this solid or cruoric part of the blood diminishes more the longer we leave the serum to separate, and that it always tends, by shrinking

ſhrinking together, to preſs out a larger portion of the gelatino-albuminous liquid.

The blood coagulates, or aſſumes the concreteſtate in cloſe veſſels as well in open ones, in the heat as well as in the cold; it is therefore, neither the air nor refrigeration which coagulate the blood, but the privation of the vital motion.

This coagulum is formed ſooner or later; its conſiſtence varies from the tremulous ſoftneſs of currant-jelly to the ſolidity of a kind of leather. In youth and in females it is ſofter; in old age its tenacity is very great. When the blood becomes covered with a buffy coat in ſome particular diſpoſitions of the ſubject, or in inflammatory affections, it is obſerved that the coagulated and red part which it covers is leſs ſolid and leſs abundant; which proves that the ſubſtance of this coat, is formed at the expenſe of that which forms the ſolid part of the coagulum. Blood received, as it iſſues out of the vein, into a ſolution of ſalts, nitrate of pot-aſh, or ſulphate of ſoda, does not coagulate.

Its ſurface which is in contact with the air is of a brilliant purple-red, its interior is dark coloured and almoſt black; but this interior part, when expoſed and opened in the air, aſſumes the clear and brilliant tinge of the ſurface. Incloſed in a veſſel full of atmoſpheric air, the coagulum quickly alters it, whilſt it becomes red, and converts the oxigen into carbonic

bonic

bonic acid. Hidrogen gas and carbonic acid gas give it a violet colour; the firſt of theſe gaſes becomes carbonated.

The coagulum corrupts rapidly and becomes inſupportably fetid. In a hot place, as a ſtove or an oven, it dries without putrefying, and becomes converted into a kind of powder. Thrown into boiling water it acquires more conſiſtence than it naturally has; its colour paſſes into an homogeneous brown; the water becomes turbid, and preſents at its ſurface an abundant ſcum; the acids thicken and harden it, at the ſame time rendering it brown. Alcohol heated upon the coagulum aſſumes a lemon colour and condenſes its texture. The alkalis on the contrary ſoften and diſſolve it; they change its colour leſs than the acids.

32. The coagulum being tied in a bag of linen, and waſhed under a ſtream of water till this ceaſes to be coloured by it, when the linen is ſlightly compreſſed between the fingers, ſeparates into two diſtinct ſubſtances, preciſely in the ſame manner as we have ſeen the paſte of the flour of wheat ſeparated into two ſubſtances by the ſame operation. We may alſo effect this ſeparation in the hand by uſing only a very ſmall ſtream of water, or upon a very cloſe hair ſeive always with the ſame precaution of employing but very little water, and receiving it gently upon the ſurface of the coagulum. Theſe two matters are, 1. the red colouring part which diſſolves in the water and runs off

in the washing; 2. a white solid substance, filamentous and flaky, which remains in the bag, in the hand or upon the sieve, and which is much less voluminous, and at the same time much more dense than the coagulum. There is this very perceptible difference between the product of this operation and that of the washing of the paste of flour, that the wheat yields starch in powder; which renders the water turbid and milky; whereas the coagulum does not render water opaque nor leave any fecula precipitated, but permits the red colour to dissolve in the liquid, which passes off transparent. By pursuing this comparison, we see also that the white concrete substance obtained as residuum of this washing corresponds with the glutinous part of wheat, and that the coloured liquor of the cruor that has been washed represents at the same time the amilaceous fecula and the mucoso-saccharine matter of the flour.

Section. VI.

Of the Colouring Part.

33. THE water which is employed for washing the coagulum of the blood, takes from it the whole of its colour and acquires a more or less brilliant-purple tinge. This is what is termed the colouring part of the blood. It appears to be

be nothing more than a dilute ſolution of albumen and gelatin, with which a ſmall quantity of iron, in the porportion of a few thouſandths is mixed. It is thus that Bucquet has deſcribed it, comparing it with the ſerum, from which it appears to differ only by the metal thus indicated. This difinition could not enable us to underſtand the adheſion of this ferrugineous ſerum with the coagulum, and the ſeparation of the white ſerum which is effected; except as a ſimple expreſſion of the thinneſt and moſt fluid part of the liquid, and as the more intimate attraction of the portion condenſed by the oxide of iron for the concrete and fibrous part of the coagulum. But ſuch a general or ſuperficial notion is not ſufficient; we muſt ſtudy with greater attention the properties of the ſanguine colouring liquor, and inveſtigate thoſe which particularly characterize it.

34. The aqueous ley of the coagulum, which is tranſparent at the moment when it has juſt been obtained, becomes turbid and depoſits membranous flakes at the end of ſome time; it turns the ſyrup of violets green. Even when heated on the water-bath, it forms a brown coagulum, which ſwims in a turbid water. This coagulum ſeparated from the liquid portion by filtration, preſſed and dried, becomes brittle, pulverulent, inſipid and inodorous. We ſee it in what is called the *ſcum of the pot*, when the entire fleſh is boiled in water. Alcohol takes from

from it but very little, and assumes a red colour. The acids blacken and alter it, they also form it and separate it from the water by coagulating it. The pure alkalis dissolve it, and it is precipitated from them by the acids. The coloured coagulum affords in distillation the same product as that of the white serum, and it presents so many analogous properties that it is impossible not to confound it with the albumen of the former liquor. One difference however presents itself when we compare their coat, since that of the red serum contains iron, as shall be shown.

35. When we separate, by the action of fire, the ferrugineous albumen from the large quantity of water in which it is dissolved, whatever temperature may be employed, and whatever time we may bestow upon this separation, we can never obtain it entire; because the part which is coagulated fixes about a fifth of water in which it was dissolved; the supernatant liquor also retains a portion of albumen, and there is established an equilibrium of combination, a mutual partition between these two bodies. Also by evaporating the liquor that is not thickened, after having separated it by filtration from the solid and coagulated matter which it contained, it presents at its surface towards the end of the evaporation, a brown pellicle, which breaks and is precipitated into coloured flakes. When it is dense and clear, alcohol heated upon it dissolves a part of it, assuming a deep brown colour,

colour, and leaves by evaporation a residuum of animal matter, soluble in water, frothing by agitation, like a solution of soap, strongly turning the colour of violets green, and precipitated by the acids. These last properties indicate that the albumen combined with soda actually resembles a saponaceous combination.

36. When Menghini discovered the presence of iron in the blood; when Rouelle confirmed it by new experiments; neither of these chemists determined in what state this metal was contained in it. Citizens Deyeux and Parmentier believed it to be combined with soda, and in a state nearly resembling that of the ferruginous alkaline tincture. The following is the manner in which Citizen Vauquelin and myself found that the iron was united in it with phosphoric acid, as Citizen Sage had announced a long time before, but without proving it, and as Mr. Grew, Professor at Halle, had asserted more positively, though he did not indicate by what means we might be convinced of it. When the red part of the water in which the coagulated blood has been washed is burned in a crucible, we obtain a residuum of a dark red colour, forms 0,0045 of the blood that has been employed, but which, when dissolved in the muriatic acid, amounts only to between 0,0017 and 0,0006 when separated from what is foreign to it, or those saline matters which do not contain iron, by the following processes. It is digested in very weak nitric acid, which dissolves

diſſolves a part of it, and leaves another more red than before. Ammonia poured into this ſolution affords a white precipitate, which when treated whilſt ſtill wet by cauſtic pot-aſh, loſes part of its weight, and aſſumes a very dark-red colour. Lime water, poured into this ley of pot-aſh, forms a white precipitate of phoſphate of lime. We may employ muriatic acid for diſſolving the phoſphate of lime, which remains after the combuſtion of the coagulated red ſerum.

37. In order that we may be the better able to conceive the nature and the ſtate of this phoſphate of iron, and underſtand how it can be diſſolved in the blood along with ſoda, it muſt be obſerved, that there are two phoſphates of this metal, the one white-grey, frequently of a pearly brilliancy, inſoluble in water, ſoluble in the acids, and the other red, more or leſs brown, and leſs ſoluble in the acids; this is phoſphate with exceſs of oxide of iron, and the other is ſaturated with its acid. The white phoſphate of iron is decompoſed only in a partial manner by the cauſtic alkalis, which take from it only a part of its acid, and leave the ſalt with an exceſs of this baſe. It is in this ſtate of phoſphate ſuperſaturated with iron, a ſtate maintained by the preſence of the ſoda, that this metal is diſſolved in the blood, and in particular in its ſerum. The blood of all animals, when it is red, is coloured by the phoſphate of iron.

38. We

38. We have found in our experiments relative to the colouration of the blood, that the ſuper-oxigenated phoſphate of iron has an exceſs of its baſe, that this phoſphate diſſolves very well, and by the ſlighteſt agitation or trituration, in raw white of egg, and in the ſerum of the blood: it is not even neceſſary to employ the aid of heat in order to effect this ſolution, ſince it takes place in the cold by mere motion, preſenting immediately a very ſtrong red colour, which reſembles that of the blood. A little pure fixed alkali accelerates this ſolution, and renders its colour more perfect and lively. Thus the phoſphate of iron, the quantity of which, though very ſmall, is ſufficient to colour the blood, exiſts in it in the ſtate of ſuper-oxidation, and of exceſs of metal; it is diſſolved in its albumen, and brightened by the ſoda contained in it. Perhaps the phoſphate of ſoda exiſting in the ſerum has no other origin than the partial decompoſition of the phoſphate of iron by the ſoda.

39. Amongſt the properties which diſtinguiſh the red ſerum, or the colouring part of the blood, we muſt particularly mention its change of colour by the contact of the air; the luſtre imparted to it by the oxigen gas, or the aërated water employed for waſhing the coagulum; the violet brown, which it contracts from carbonic acid gas, and eſpecially from carbonated hidrogen gas; the influence which it has upon the alteration of the air, the formation of carbonic acid which it excites, and the abſorption of oxigen which it produces. If theſe phenomena

 are

are more energetic and more prompt in the red ſerum than in the white, and if the difference which exiſts between theſe two ſpecies of ſerum entirely depends upon the preſence of the ſuper-oxigenated phoſphate of iron which the firſt contains, it is evident that this metallic ſalt is the cauſe of the colouration of the blood, and of the luſtre which this colour acquires by the contact of the atmoſphere, as alſo of the changes which this red ſerum, at the ſame time, occaſions in the air in which it is immerſed.

40. Citizen Deyeux believes, that the colouring matter of the blood, beſides albumen, gelatin, the phoſphate of iron, and the ſalts, which analyſis has diſcovered in it, contains a particular ſubſtance, to which he attributes ſeveral of its characters, and eſpecially the homogeneous concretion of the entire blood in the preparation of puddings; on which account he calls this ſubſtance *matière tomelleuſe*. It is ſince his inveſtigations concerning the blood that he appears to have directed his attention to this matter, as he had ſaid nothing at all of it in the Journal de Phyſique, in which his firſt analyſis is inſerted. He has diſtinguiſhed the tomelline; for it is uſeful to give to his name a termination ſimilar to that of ſeveral other animal ſubſtances, with which it appears to have much analogy in its form, its conſiſtence, as well as in ſeveral properties which have appeared to him to be different from thoſe which are known in the albumen, the gelatin, and the fibrine.

But

But he has himself given the first notions relative to this particular matter, only as mere ideas, which deserve to be verified and pursued, in order to receive from experience, that confirmation which alone can prove the existence of this new body.

41. I must not omit, amongst the properties of the colouring matter, or of the red serum of the blood, that of dissolving copper, which presented itself to Citizen Vauquelin with so remarkable an energy as to induce him at first to believe that the blood contained this poisonous metal amongst its principles. The following is the manner in which this discovery presented itself to him. Having boiled the water in which the blood had been washed in a very clean copper kettle, in order to coagulate the albumen, and having filtrated the liquor in order to collect separately the coagulated matter, with the intention of carefully examining its colouring part, he burned this concrete substance in an earthen crucible, and dissolved its ferrugineous residuum in the muriatic acid. When he attempted to precipitate the solution by ammonia, he was much surprized to see the liquor, which contained an excess of this alkali, assume a beautiful blue colour. The liquor was saturated and discoloured by the muriatic acid, and a plate of iron that was immersed in it became covered with a brilliant stratum of copper, the quantity of which was sufficiently considerable after two days to be able to be separated and

 detached

detached from the iron. The water from which the coloured albumen had been separated by coagulation, contained no copper; whence Citizen Vauquelin concluded that the solution of the copper was owing to the albumen; that it was effected at the moment of the separation of the albumen by the heat; that the copper combined and precipitated itself with the concrete albuminous matter. In fact, this more oxigenated part of the blood exerts a very marked attraction upon the metallic oxides, combines with them with considerable force, and separates them, as we have seen, from the acids. According to this fact, it is an important caution, that blood prepared for food should not be boiled in copper vessels. It is also to be observed, that in precipitating an alkaline ley of blood by the acids, we obtain more Prussiate of copper than even Prussiate of iron. The first is recognized by its purple-red colour when it is moist, and its dark-red colour when dry.

42. The red serum of the blood, or the colouring part of this liquid, obtained by washing the coagulum, after the separation of the serum, or of the white serous part, is therefore composed of a large quantity of water, of albuminous and gelatinous matter, of super-oxided phosphate of iron, of soda, and of some saline substances. The latter, and particularly the phosphates and muriates, are much less abundant in it in their proportion with the albumen than

in the ferum properly fo called, fince this, which has flowed fpontaneoufly out of the coagulum, and which was its moft fluid part, muft have carried off with it all the more foluble parts that were contained in it, and the falts hold the firft rank in this order. It is very evident that we do not fpeak here of the proportion of the materials of the red ferum to the water which diffolves them, as we may confider it in the white ferum, becaufe the quantity of the water added, depends entirely upon the will of the perfon who operates, and the procefs which he employs. The fuper-oxigenated phofphate of iron, or the red phofphate of iron, which colours this ferum, feparated from the coagulum, is diffolved in it by the albumen, and is precipitated with it when the fire coagulates and feparates it from the water; this albumen retains even a part of its diffolvent activity, fince befides the ferruginеous falt which it naturally contains, it re-acts fo quickly and fo powerfully upon the copper, and undoubtedly upon other metals. We may underftand the fimultaneous prefence of phofphate of iron, and of foda in the blood, when we know the fixed alkali decompofes this metallic falt only in part, and reduces it, like the Pruffiate of iron, only to the ftate of phofphate with excefs of iron, or red phofphate, and that it is in this ftate in the blood; we comprehend it ftill better when we recollect that iron, which is oxided in a folution of phofphate of foda, decompofes a part of this falt, and paffes into

into the ſtate of ſuper-oxigenated phoſphate of iron. Perhaps, it is alſo in this manner, that this ferrugineous ſalt is formed in the blood, and that the ſeparation of the ſoda is effected.

SECTION VII.

Of the fibrous Part of the Blood, or of the Fibrine.

43. WHEN the coagulum, tied in the linen bag, has been well waſhed, there remains a white matter in hard filaments, interlaced with one another in a texture reſembling felt, which has been called *fibrous matter*, and which is denominated *fibrine* in the methodical nomenclature. This ſubſtance ſeparates itſelf from the blood when it is agitated in the ſhambles, and attaches itſelf to the ſticks with which it is ſtirred, in the form of ſmall ſolid faſciæ, twiſted together like intermingled threads, of a roſe-colour, which become white by waſhing. We conſtantly find it ſtill floating in ſmall flakes, or in whiteiſh fibres, in the water into which the blood is received in blood-letting at the foot; ſometimes ſimilar filaments come away with the blood in veneſection at the arm, and it cannot be doubted, that to theſe filaments are to be attributed the pretended worms which have

been said to have seen issuing out of opened veins.

44. The fibrine when well prepared, drained upon paper without size, and dried in a stove, thereby loses two-fifths, or between 0,39 and 0,40 of its weight. The medium quantity of this matter, taken from the blood of six different persons, amounted in our experiments to 0,0028; in the blood of a greater number of persons compared, the *minimum* of its proportion was 0,0015, and the *maximum* 0,0043. The fibrine is void of taste, and of such consistence and tenacity in its texture, that animals cannot masticate it without much difficulty. When it is exposed suddenly to a violent fire, it shrinks and moves like parchment. When distilled by naked fire, and in a retort, it affords water charged with carbonate of ammonia, a thick, heavy, and very fetid oil, and much concrete ammoniacal carbonate. There is also disengaged from it carbonated hidrogen gas, and carbonic acid gas: it is one of the animal substances which furnish the most oil and ammonia; accordingly, I have indicated it as a substance particularly azoted. The coal which it leaves after its distillation is compact, heavy, and rather difficult to be incinerated. We find only phosphate of lime in its ashes; we extract it and ascertain it by dissolving it in the nitric acid, and precipitating it by ammonia. It contains neither soluble phosphate nor iron.

45. The

45. The fibrine putrifies quickly and violently in water; it exhales a fetid ſmell, and is converted into an adipocirous fat ſubſtance; there is alſo diſengaged from it much carbonate of ammonia during its putreſcence. It is not ſoluble in water, and when left for a long time in this liquid in the boiling ſtate, it becomes hard like horn, aſſuming a grey colour. The alkalis, diluted with water, have very little action upon it; it is equally inſoluble in ammonia. The leys of cauſtic fixed alkalis, barites, pot-aſh, ſoda, and ſtrontian, highly concentrated, attack it, however, with the aid of heat; they give it a brown-red colour, diſengage ammonia from it, ſoften it, and at laſt entirely melt it. The reſult is a kind of bitter fluid and viſcous ſoap, which the acids and the metallic ſalts decompoſe.

46. The acids have a much more ſenſible action upon the fibrine. Even the weakeſt diſſolve it. Weak nitric acid diſengages from it in the cold much azotic gas, afterwards with the aid of heat Pruſſic acid gas, and carbonic acid gas, mixed with nitrous gas; there are then formed yellowiſh fatty flakes, and the liquor holds oxalic acid in ſolution. The concentrated ſulphuric acid reduces it to coal, converting it in part into water and acid. The muriatic diſſolves it, and gives it the form of a green jelly. The acetous acid alſo diſſolves it, like the citric, tartarous, and oxalic acids, with the

the aid of a gentle heat. All these acid solutions assume, when they are concentrated by evaporation, or otherwise well saturated, and by cooling, the gelatinous form: they then resemble a real jelly. The alkalis precipitate the fibrine from these acid solutions in flakes, altered indeed, and which have become soluble in hot water; it would then seem that it has assumed the character of gelatinous texture, and that it has experienced a kind of retrogradation in its composition.

47. We must add to these properties, which are already very capable of characterizing the fibrine, and distinguishing it from the other animal substances, that it affords, amongst the products of its distillation, a remarkable quantity of the zoonic acid, discovered by Citizen Berthollet, and that it thus exhibits, in the experiments to which it is subjected, a very animalized matter, very much azoted, especially which represents almost the last term of animalization, or of the animal composition. It is, perhaps, to an alteration of this substance, analogous to what takes place with it in its conversion into zoonic acid, that we have to attribute the acidification observed by Citizen Chaussier, who asserts, that he has extracted a particular acid from the coagulum treated by alcohol.

48. Notwithstanding the small quantity of fibrine contained in the blood, we shall see hereafter, that it acts a very important part in the animal organization, and in the life of animals,

since

ſince it depoſits itſelf in their muſcles, the particular texture of which it conſtitutes, and ſince it becomes the ſeat of one of the moſt important and moſt incomprehenſible vital functions, that of irritability, and conſequently the principle of the motion which preſides over all the other functions, from that of the heart, in which the ſupport of life reſides, to that of the ſmalleſt muſcular fibre.

Section VIII.

Of the principal Differences of the Blood.

49. It is not ſufficient to have examined the entire blood, and its different elements, or immediate materials in the moſt general circumſtances, or to have determined its properties, that are in ſome ſort mediate or common. Chemiſtry can proceed ſtill much farther; it ought to embrace a ſtill much greater whole, and apply itſelf to much more extenſive details. It is its buſineſs to appreciate the differences which this vital liquid preſents, according to the places which it occupies in the body, according to the ages and the ſex which modify it, according to the different orders of animals to which it belongs. Though the analytical labours which theſe data require, in order to be obtained, are yet but ſmall

advances,

advances, chemical knowledge has, neverthelefs, already thrown fome light upon thefe confiderations; and it is important to collect thofe lights, as it were, into a focus, in order at leaft to illuminate the entrance of an immenfe courfe, which medicine expects in this refpect from Natural Philofophy, which muft preceed her in his route hitherto fo little frequented.

50. The ancients had fome notions concerning the difference of the blood contained in the two orders of arterial and venous veffels: by admitting in the firft, a fpirit, or an elaftic air, they feemed to have confidered the blood which circulates through them, as rarefied, aërated, and frothy. It is no longer doubted, fince Harvey, that the blood of the arteries is more red, more hot, more rare, and more irritating than that of the veins, and pneumatic chemiftry has fhown, that in fact the arterial liquid owes thefe properties to the oxigen gas which it abforbs in the lungs, and to the lofs which it has there fuffered of a portion of its hidrogen, and of its carbon. In proportion as it circulates, it lofes both its heat, and its oxigen, and its proportions; fo that having become of a brown-red colour, lefs hot, lefs concrefcible, more hidrogenated, and more carbonated in the veins, it is difpofed to become oxigenated, heated, dif-hidrogenated, and decarbonated in the pulmonary veficles; and we fhall fee that refpiration has thefe fimultaneous effects, as its object and its function.

51. To

51. To this difference of the blood in the system of the arteries, and in that of the veins, we must add that which it acquires in the different regions through which it circulates. It has been believed to be more light, more aërial, more spirituous in the vessels of the head, and disposed thereby to form the nervous fluid or the vital spirit, which as yet is indeed only an hypothesis. It is known, that it is fat and oily, or at least very much disposed to become so in the abdomen, and especially in the system of the vena porta; that it also undergoes a change that has not yet been appreciated in the spleen; that it is very much attenuated, and replete with life and activity in the spermatic system. There is also no doubt, that it has a very particular character in the vicinity of the kidneys, and especially where it issues out of this urinary organ, and in the emulgent veins, though it is not known in what this character consists. It is no less evident, that near to the heart, and before it enters it in order to be sent into the aëriferous apparatus of the lungs, the chyle which it receives, modifies and renovates it by furnishing to it a pure source of continual reparation. We cannot mistake the particular disposition which it has to become solid and converted into fibrous texture, which it affects by being retarded in those arteries, almost always retrograde, which carry it into the muscular flesh.

52. Mere

52. Mere inſpection is ſufficient to ſhow, that the blood varies according to the age and ſex of the individuals. That of the fœtus differs eſſentially from that of the infant after reſpiration has commenced, becauſe the air has not yet touched or impregnated it. Already the firſt experiments which I have been able to make upon this ſubject, have ſhown me that the blood of the human fœtus which has not yet reſpired, contains inſtead of the fibrous matter, only a ſoftiſh texture, without conſiſtence, and as it were gelatinous; that it is not ſuſceptible of being reddened by the contact of the air, like that of the adult, and that it preſents no phoſphoric ſalts.

Sometime after birth the blood aſſumes a bright colour, a more conſiderable concreſcibility, and it becomes enriched with phoſphates, eſpecially with that of lime, which being furniſhed in conſiderable abundance by the milk of the mother, quickly carries the ſolid matter to its bones.

At the age of puberty the blood is more hot, more highly coloured, more irritating, more odorous, and vivified by the ſpermatic emanation which prevails; moved with force in its ſtrainers, it tends to eſcape from them: and this is the epocha of turgeſcence and of hæmorrhages.

The blood of the ſubject that has become adult, and in the permanent vigour which ſucceeds youth, has more conſiſtence and more fibrous matter.

In

In old age, it loſes part of its energy, its heat, and its plaſtic property, but it becomes more diſpoſed to be detained, and to form concretions of ſeveral kinds.

The blood of the female preſerves for a long time the character of the blood of youth; it has been ſuppoſed, that the uterine and the menſtrual blood have ſome particular qualities, a diſtinct ſmell and vapour which act at a diſtance upon flowers and fruits, upon liquors in the the ſtate of fermentation, the colouring matters, &c. When we ſeparate from this opinion what is erroneous and exaggerated in it, it preſents to the impartial obſerver ſomething true, which ought to be aſcertained by exact experiments, inſtead of denying what has not yet been comprehended.

53. The different orders of animals have certainly differences in their blood, proceeding from those of their nouriſhment, of the digeſtive, reſpiratory, &c. organs. The chemical inveſtigations by which theſe differences are to be aſcertained, have hardly been commenced; we have yet only very few general obſervations upon ſome of the properties of the blood, compared in the different orders of animals.

A. That of the mammalia approaches very near in its nature to that of the human ſpecies; like the latter, it contains a white ſerum, ſerum coloured by ſuper-oxidated phoſphate of iron, fibrine, muriates of ſoda and pot-aſh, phoſphates of ſoda, and of lime and ſoda, the pro-

portions

portions of which vary in each particular animal, as Rouelle the younger has ſhown, by giving a table of the quantities of ſalts which he had extracted from the blood of the horſe, the bullock, the aſs, the calf, the ſheep, the goat, and the hog. This chemiſt was much aſtoniſhed, that the animals which eat vegetable food, and conſequently pot-aſh, conſtantly preſented free ſoda in their blood; however, it is eaſy to conceive, that the pot-aſh ought to decompoſe the muriate of ſoda. He found no phoſphates in it; for the knowledge of theſe we are indebted to my analyſes made ſince 1780.

B. The blood of birds is in general more red and more hot than that of the mammalia, and very quickly becomes fixed or coagulated; its coagulum is gelatinous; it does not ſeparate from the ſerum except with difficulty. Its colour is never ſo brown or ſo dark as that of the blood of men, and of the mammalia. No comparative analyſis has yet been made of it; we know neither the proportions of its parts, nor the ſalts that are contained in it.

C. The blood of the amphibia, and of the fiſhes, is as little known as that of the birds; no chemiſt has yet examined it; we only know, that it is colder, very little ſuperior to the temperature of the air or the water in which theſe animals live, that it is little concreſcible, and that it appears extremely diſpoſed to become oily.

D. As

D. As to the mollufca, the infects, and the worms, it has been believed, that they have a white or little coloured blood, but no experiments have been made in order to afcertain the characteriftic properties of this liquid. However, there exifts in feveral of thefe animals a red blood, analogous in its appearance to that of the preceding. It is needlefs to obferve, that an exact analyfis and comparifon with that of the kinds of blood already, will throw much light upon the functions of thefe beings.

Section IX.

Of the Alterations of which the Blood is fufceptible.

54. ONE of the moft important refults which medical philofophy expects from the refearches of chemiftry refpecting the blood, confifts in appreciating the changes and alterations in the different morbid affections; but thefe refearches have fcarcely been as yet commenced. Citizen Deyeux and Parmentier have juft begun to examine the blood in fome difeafes. They have found in general that the albumen is the element the moft altered in this liquid; they have made fome experiments

ments upon the blood of subjects attacked with inflammatory diseases, with scurvy, and with putrid fever.

55. The blood, which is called *inflammatory*, taken from pleuritic patients, presented to them a buffy coat which covered its surface, a soft coagulum, a coagulation as it were partial, filamentous and interrupted in the heated albumen, the impossibility of causing it to coagulate in boiling water, and the property of giving it a milky colour. The buffy coat appeared to them to be formed of the fibrin altered, softened, melted into a kind of gelatin, soluble in the acids; accordingly the blood upon which it is formed presents a very soft coagulum, which scarcely affords any fibrin when it is washed, or which dissolves almost entirely in water. We see that the inflammatory character of the blood consists in melting, or liquefaction of the fibrous part and of the albuminous matter, instead of the thickness and coagulation which had been supposed to exist in it, and that the substances which, in the healthy state, tend to concrescibility and separation have lost this property. I do not however consider it as demonstrated that the buffy coat proceeds from the fibrin; it appears to me more natural to consider it as super-oxigenated albumen, which carries with it a portion of fibrin on account of is concrescible power, whilst in the natural state it is the fibrin which retains a portion of the albumen.

 56. The

56. The blood of three fcorbutic patients, which had been drawn on account of the pain and the plethora which exifted in thefe perfons, from twenty-nine to forty-feven years of age, exhibited to Citizens Deyeux and Parmentier phenomena different from thofe which had been announced in this liquid. It had neither a greater fluidity than in the ordinary ftate, nor the abfence of coagulation; it became concrete; its albumen was lefs concrefcible by heat. The coagulum wafhed with water afforded fibrin in elaftic filaments; upon one of them there was formed a buffy coat, only lefs thick than in the inflammatory blood, and which became friable by deficcation; the water in which the coagulum had been wafhed, or the colouring part, afforded membranes that floated in it. This blood had not its ufual fmell: the white ferum was feparated from it in the accuftomed manner, and was not more abundant than in the ordinary circumftances. For the reft, the chemifts of whom I fpeak believe that only erroneous inferences can be deduced from the quantity of ferum feparated from the coagulum of the blood. According to them, its fpontaneous effufions in the hemorrhages fo frequent in fcorbutic patients do not proceed from its fufion and greater fluidity, but from the weaknefs and relaxation of the veffels which contain it. There is reafon to believe, that a want of oxigenation is the principal character of the blood in fcorbutic patients, and that it is on

this

this account that this liquid forms the violet spots upon the skin, and that the sea scurvy begins with a considerable degree of corpulence.

57. The blood taken from the product of venesection at the arm, performed during the first days of the attack of putrid fevers, and in subjects with whom the symptoms manifestly indicated this disease, presented to them sometimes a buffy coat, and sometimes none; the serum generally appeared to them difficult to be separated, and adhering very strongly to the coagulum. They found it likewise either very marked analogies with that of inflammatory fevers, or nothing particular; they in vain sought to discover in it those signs of putridity with which so many authors have asserted that is tainted in this kind of affections, and to which they have attributed their cause. Distilled on the water-bath, this blood afforded them no ammonia, as might have been expected; exposed to a mild temperature, it did not putrefy more rapidly than the blood of a healthy person. According to them, therefore, there does not exist in it any particular principle of putridity, which has so often been said to characterize the diseases of this kind. It is only in the excrementitial liquors that this tendency to septicity, and even an incipient putrefaction, appear in putrid fevers: the blood does not partake of this property.

58. The chemifts, of whofe labours I have juft given an account, have confined themfelves merely to thofe refearches, becaufe the Society of Medicine, to whom they have addreffed their Memoir, had fpoken only of thofe affections in the programma of the prize which has been awarded to them. But how many other important queftions ftill remain to be treated! how many ufeful problems to be refolved in this kind of experiments! The blood has a very remarkable character in thofe purulent difeafes, in thofe great internal fuppurations in which it appears to be converted fo eafily and fo fpeedily into pus. Another prefents itfelf, of equal importance to be determined, in chlorofis or the green ficknefs of young women, whofe arteries and veins are filled with a liquid fcarcely fanguine, of a light rofe colour, and fometimes white. With dropfical patients it has already been feen dry, gluey, vifcous, and brown; it cannot be doubted that it has fuffered a kind of decompofition which fhows itfelf efpcially by the feparation of the ferum; for the water of hydropic cafes has the greateft analogy with this humour. The affections in which the fuper-abundant bile accumulated in its canals, feems to diffufe itfelf into the fanguineous fyftem, as phyficians have long fince obferved, prefent to chemifts an ufeful opportunity for afcertaining whether the means of their art will lead to the demonftration of the

prefence

presence of the bile in the blood. The same is to be said of the melaena or morbus niger, of the adipose and lacteal cachexies, and of a multitude of other affections in which the blood assumes a particular character, which is known by the practical observer, and which awaits from chemistry a more exact determination, a more positive definition, than mere inspection has hitherto been able to furnish.

Article III.

Of the Lymph.

1. THE lymph is a white transparent liquid, contained and circulating in an order of vessels very well known at present, the extremities of which, opening into all the cavities, suck in or absorb the liquor effused by the extreme arterial ramifications, and the trunks of which unite with the reservoir of Pecquet and the thoracic duct; so that the lymph appears to be taken up at the extremities of the arteries, and carried into the veins. This humor is one of the most abundant in the body, as the canals which contain it and transport it are extremely numerous. Divided into two general layers, the one superficial and the other deep seated, they exist in all parts of the animal economy, they traverse all its regions; they wind along its surface and between the fibres of the muscles; they cover, and as it were envelope all the viscera.

They

They therefore announce an important function; and the liquid which distends their conical cavities separated and contracted from space to space by valves, must serve for purposes both numerous and necessary for the support of life.

2. Notwithstanding all the interest which the knowledge of the nature of the lymph must possess for animal physics, this knowledge is as yet but very superficial or vague, or even erroneous: no author has occupied himself with it in particular; chemical science cannot yet present any analysis of this humour. From Bartholin and Rudbeck, the first anatomists who discovered these absorbent vessels towards 1650, to the last very extensive and accurate researches of Mascagni and some other moderns, every thing has been done for the knowledge of the structure, the number, the disposition, and the course of these absorbent vessels, but nothing has yet been done as to that of the lymph which they convey. Indeed we have not the means of procuring this liquid, as we have of obtaining the blood. Though at present the most of the absorbent vessels have been well described, and though the course of a great number of them are known, we are as yet ignorant of the art of extracting the lymph pure; no *lymph-letting* is performed, whereas blood-letting is performed with great facility.

3. Some circumstances of chirurgical diseases, however, afford opportunities for making experiments upon the lymph. In wounds and ulcerations

cerations of the inguinal and popliteal regions, it ſometimes happens that the trunks of abſorbent veſſels are opened, and that the lymph flows out of them in ſuch abundance, that the clothes and dreſſings are very ſtrongly impregnated with it. I recollect having ſeen two ſuch caſes in an hoſpital in Paris; but I was then too young and too little advanced in this kind of reſearches to have derived the advantage from them which they might have afforded me. Similar circumſtances are perhaps not ſo rare as might be believed; and it is to be hoped that thoſe to whom they may hereafter preſent themſelves, will not let them eſcape without availing themſelves of them for the benefit of the art. Perhaps even, if we ſhould direct our views towards this kind of reſearches, we might acquire the art of opening abſorbent veſſels at pleaſure, and by this kind of lymph-letting imitate what is performed in blood-letting. There is even ground to believe that this ſpecies of operation may ſometime fulfil uſeful indications, remedy lymphatic plethora, diminiſh the maſs of ſuper-abundant white and nutritive juices, evacuate this humour accumulated in the cavities: for the depletion of a large lymphatic veſſel, and the vacuum by which it would be followed, muſt augment the force of ſuction and abſorption in one of the regions, and conſequently in the whole continuity of the abſorbent ſyſtem.

4. Whilſt

4. Whilſt I await the fulfilment of my wiſh that this idea may ſtrike deeper root in the learned and medical world, I muſt at leaſt collect here what has been ſaid concerning the nature of the lymph. Inſtead of taking this liquid in its own canals, and for want of the humour itſelf which we have not yet been able to extract from its proper reſervoirs, the ſerum of the blood has in ſome reſpect been ſubſtituted in its place, and repreſented as the lymph in moſt works of medicine and phyſiology. Haller himſelf, though otherwiſe ſo exact, and who preferred facts to any hypotheſes, has followed this method. We find it indicated in a great many places of his immortal work, and particularly in the article concerning the ſerum of the blood, and in the ſketch of the chemical claſſification of the humours which precedes his hiſtory of ſecretion. Moſt of the phyſiologiſts who have written ſince him, and who may almoſt all be conſidered as his copiers or plagiaries, have had no other idea. Dehaen, who however has endeavoured in his works to introduce more preciſion into the theory of the humours and of their morbid alterations, has followed this opinion. I know only Bucquet, who, in his Courſe of Lectures, has combated this ſimilitude adopted between the ſerum of the blood and the lymph, and who has inſiſted not to prove that theſe two liquids are not the ſame, for of this we have not acquired any certainty,

certainty, but to show, that as long as the lymph shall not have been particularly examined, we can have no certainty that it is of the same nature as the serum, and that we are no less authorized to suspect it to be different than to assert that it is analogous with it.

5. Haller, where he quotes the anatomical and physiological labours of Stenon, Bartholin, Drelincourt, Bellini, Wepfer, Werreyen, and Monro, and calls the lymph serum, and the serum of the blood lymph, indiscriminately with these celebrated men, ranks the latter humour amongst the gelatinous; but we soon perceive that he gives this name of *gelatinous humours* to those which I call *albuminous*, since he indicates at the same time the concrescibility by fire as their distinctive character. He therefore announces that the lymph is coagulated by heat, by the acids, by alcohol, that it is saline, slightly viscous; that it froths by agitation; that it concretes into solid flakes by the action of boiling water; that it is soluble in cold water; that it yields by distillation a fetid oil and concrete volatile salt or carbonate of ammonia; that salts are found in solution in it: in a word, he composes its history and the totality of its properties of all those which belong to the serum of the blood. He makes of it really an albuminous humour; he adds that it renders the oils miscible with water, and he proves it by the absorption of the fat effected so easily and sometimes so speedily by the lymphatic

phatic vessels. He even takes care to distinguish well from this liquor, as from the serum of the blood, the mucous humours which answer to those which I call *gelatinous*, as he assigns to these the character of not being coagutable, but on the contrary fusible by the action of heat, of being very transparent and glutinous. Senac, Quesnay, and Dehaen, had already admitted a like distinction.

6. Without denying the possibility of this identity, or at least of a very strong analogy between the lymph and the serum of the blood, which may in fact be considered as its first source, we cannot however avoid two reflections equally just and important: the one that there is wanting to the proof of this analogy an analysis of the lymph taken in its tubes, and compared with that of the serum, as Bucquet said; the other, that even admitting the serum of the blood to be the only source of the lymph, it is natural to conceive that there exist in the latter more or less considerable differences from the albumino-mucous liquor of the blood, since the latter must, during circulation by serving for several different uses, passing through different organs, furnishing several secretions, losing some of its principles, have experienced an alteration sufficiently considerable for it no longer to be capable of being considered as having exactly preserved its primitive nature and composition.

7. Were

7. Were we permitted to indulge ourfelves in conjectures founded upon fome facts which may render them probable, we might believe for example, that by the effects of the fixation of oxigen, of the difengagement of heat, of the lofs of water, or of hidrogen, and of a portion of its carbon, effects which, having commenced in the lungs, are continued throughout the whole route which the blood takes during its circulation, the blood paffes gradually into the ftate of fibrin; that in proportion as this takes place, the albumen which remains without this converfion becomes more oxigenated, more concrefcible, more plaftic, and that one of its parts difazoted, difhidrogenated, and carbonated, forms the animal mucilage or the gelatin. The lymph then, which would be in fome meafure the refiduum of this portion of albumen converted into fibrin, which continues as fuch, either to conftitute the blood or to form the mufcles, would contain a portion of highly oxigenated albumen, and a larger quantity of gelatin. Thus the hæmatofis would terminate by a feparation of the blood into three different matters: the one highly azoted, or the fibrin; the fecond highly oxigenated, or the very concrefcible albumen; and the third highly carbonated, or the gelatin. A portion of the two laft diffolved in water would form the lymph, and a portion of the fibrin depofited with the colouring matter in

in the mufcles would fupport their nutrition and life.

8. But though this conjecture accords well with the knowledge which we have concerning the comparative nature of the three matters which enter into the immediate compofition of the blood; though we fee in many chemical operations upon the animal matters a fort of partition of their primitive homogeneity into two or three different fubftances, it will always be merely an hypothefis till a careful analyfis of the real lymph, compared with that of the ferum of the blood, fhall have decided upon the probable difference which exifts between them, or upon the analogy which has already been fuppofed between thefe two liquids. It muft never be forgotten that our knowledge of the very prompt alterability of the animal liquids renders the difference infinitely more probable than the analogy between thefe two liquids; and that the lymph may very well not be what I have fuppofed it, without on that account being in all refpects fimilar to the ferum, as the phyfiologifts have admitted by a decifion too precipitate and too little founded upon facts not to be an error.

ARTICLE IV.

Of the Fat, and the Sebacic Acid.

1. THE fat is an animal oil more or lefs fluid and running, or at leaft foft in the living animals, which confequently ought to be ranked amongft the liquids. As it is almoft univerfally diffufed in all the regions of the bodies of animals, I have placed it in the firft clafs of their immediate materials. It is lodged in fmall facs formed by the cellular texture; in which it even affumes, as in a mould, the form of their interior fides. Accordingly, we almoft always find the fat in kinds of lumps or pieces of flat, orbicular or irregularly fquare figures. When we examine it by the microfcope, we fee it formed of veficles filled with a tranfparent humour. Wolf has compared the fats of feveral animals in this point of view. In diffections and when the vital heat is extinct, we find the fat more or lefs folid; but the foftening which it undergoes between the fingers is of itfelf fufficient to prove that it is liquid and running in the organs of living animals; befides, many anatomifts have feen it, on opening the bodies of living animals, in a real ftate of fluidity.

2. The fat has a fweet and faint tafte, a very flight odour when it is hot, a fpecific weight inferior

inferior to that of water, at the top of which it floats. Its taſte is ſometimes a little acrid, and its ſmell rather ſtrong in ſome kinds of animals, eſpecially in thoſe whoſe muſcles are black and which naturally uſe violent exerciſe. Though its colour is in general pretty white, it however varies from the greyiſh white to a more or leſs orange-yellow, greeniſh or reddiſh colour throughout the whole ſcale of animals. The ſame is the caſe with its conſiſtence, which extends from the fluidity of an oil to an unctious ſoftneſs in theſe beings whilſt living, and from this ſoftneſs to a dry and brittle denſity after death and after the ceſſation of the vital heat.

3. The fat is found abundantly diffuſed under the ſkin, where it forms immediately under the cutis a more or leſs thick integument. There is much of it at the ſurface of the muſcles between the intervals of the different ſpecies of theſe organs and in the interſtices of their fleſhy faſciæ. We alſo meet with a remarkable quantity of it round ſome parts of the articulations, in the ball of the eye where it envelopes the muſcles along the veſſels of the neck, in the mediaſtinum and at the baſe of the heart, round the ſtomach and the inteſtines. It is eſpecially in the vicinity of the kidneys and in the membraneous duplicature of the epiploon that it is accumulated in great abundance. If there be little of it round ſome of the muſcles which are conſtantly in motion, there is on the contrary a

conſiderable

considerable proportion of it upon the large muscles of the abdomen, and on the outer part of the buttocks which it partly causes to project in the human species, whilst no animal presents this protuberance of the buttocks. It is also abundant upon the breast, round the mammary glands in women, in whom it determines the prominent, rounded and graceful form of the bosom. The folds of the great articulations also present a remarkable redundance of it, as well as the palms of the hands, the soles of the feet, the tendinous extremities, mucous bags or capsules destined for facilitating the sliding of the tendons. There are very few animals which present any in their brain, upon the forehead, upon the cartilages of the nostrils, of the ears, round the lungs, or the penis ; it constitutes in general the twentieth part of the weight of a man. Its quantity varies according to the different animals and according to a multitude of circumstances.

4. Some anatomists have admitted particular organs for the formation of the fat. Malpighi, in describing the adipose glands, believed that there existed also vessels for conveying it into the different parts ; but neither the one nor the other of these organs have been seen and confirmed since him. It is generally believed, with Haller, that the fat is separated from the blood in the arteries ; that being formed in these vessels it is carried by its specific lightness to the circumference of the sanguineous cylinder, which

diſtends the arteries, and puſhed through ſmall orifices, with which their ſides are ſuppoſed to be perforated, into the cells of the mucous texture. In order to prove this opinion, Haller lays great ſtreſs upon the phenomena of injections which exude through all the lateral points of the arteries; he adduces that the fat frequently exhibits points and a red tinge of blood extravaſated through the ſides of arteries after animals have been violently hunted; that Morgagni has ſeen fat run in drops from divided veſſels; that Malphigi aſſerts that he has ſeen it in the arterial and circulating blood of frogs, and that Gliſſon and Ruyſch have diſcovered it in the blood of ſcorbutic patients. Reſt, abundant nutrition, diminution of the ſecretions, and eſpecially of perſpiration, the debility and relaxation which follows hærmorrhages, caſtration, are the circumſtances which favour its formation. A marked diſoxigenation in the blood is its primitive ſource, according to the principles of the French pneumatic chemiſtry, ſo well applied by Dr. Beddoes. We ſee birds become fat during a fog of ſome hours continuance, (qu.) eſpecially ortolans, robin red-breaſts, thruſhes, &c. The abſorbent veſſels ſuck it up and cauſe it quickly to diſappear in the animals that ſleep during the winter, or in fibrile diſeaſes, in great ſuppurations, during violent exerciſe, in conſequence of the uſe of acrid food the abuſe of vinous or ſpirituous liquors, mercurial frictions, &c.

5. The

5. The chemical nature of fat was not known till within a few years paſt. Olaus Borrichius was the firſt who paid particular attention in the ſeventeenth century, to the acrid and ſtrong ſmoke which is diſengaged from this ſubſtance when ſtrongly heated, and deſcribed the bad effects which it produces upon perſons who expoſe themſelves to it. In 1740, Grutſmacher, from the action of the powerful acids upon the vegetable oils, conſidered fat as an oil thickened by an acid. His opinion was followed by all the chemiſts down to our own time. Grutſmacher occupied himſelf with this acid of fat in 1748. Rhades, having been engaged in the inveſtigation of animal matters by the inſtances of the celebrated Haller gave ſome details relative to this humour in a Treatiſe publiſhed at Gottengen in 1753. Knape conſidered this acid when rectified as very ſtrong and forming a particular ſpecies. A year after the inveſtigations of Rhades, Leyner gave an account of a ſeries of experiments upon the acid of fat, upon which he publiſhed a particular diſſertation. However, notwithſtanding theſe preliminary labours, D'Aumont did not heſitate to deny, in the firſt edition of the Encyclopedia, the preſence of an acid in the diſtillation of fat. Haller re-eſtabliſhed the truth in the ſupplements which he added ſome years afterwards to the medical articles of that work. Crell, in 1779, publiſhed a long Diſſertation and an extenſive ſeries of experiments upon fat and its acid; he ſhowed

how to extract and purify it; he described its distinctive properties and its saline combinations. Since him, all the chemists have confirmed as well as extended the results of Crell upon the acid extracted from fat. Maret, in the academical courses at Dijon, repeated his experiments and added some facts to them. Citizen Guyton has published an accurate history of them in the first volume of the *Encyclopédie methodique*, or that in which the order of the subjects is followed; he there especially maintains the existence of this acid ready formed in the fats. Citizen Berthollet has proved the presence of oxigen in them, and has ably described the mode of their action upon the metallic oxides. I have also occupied myself with the chemical properties of this animal compound; I have found that the sebacic acid does not exist in it ready formed, but that it requires the decomposing action of fire in order to obtain it; I have shown that the nitric acid oxigenates fat and renders it capable of acting in a very remarkable manner upon the animal economy. It is since this period that it has been employed with success in the itch, in inveterate herpetic eruptions, cutaneous syphilitic symptoms, &c. I have discovered the possibility of explaining its formation, its fusion, &c. by the chemical attractions and the state of the blood in living animals: finally, I have determined the difference of some species of fat.

6. The

6. The firſt experiment, or firſt proceſs which is practiſed upon fat, conſiſts in its purification. It is known that this humour, ſuch as it is, extracted from the body of animals, is mixed with cellular texture and with lymphatic veſſels, with blood and with gelatinous mucilage; that it is very ſuſceptible of alteration: In order to purify and preſerve it, it is cut into ſmall fragments; the moſt apparent and the largeſt membranes and veſſels are ſeparated from it; it is carefully waſhed, with much compreſſion, in a large quantity of water; it is even triturated with water in a mortar; it is melted in a veſſel of porcelain or pottery with a ſmall quantity of water; this is ſuffered to be diſſipated till the crackling noiſe which indicates its paſſage through the fuſed fat and its evaporation into the air is no longer heard; it is carefully ſcummed in order to ſeparate from it portions of the ſolid parts which may remain in it; it is poured into a cold and new veſſel, in which it becomes fixed in a white, granulated and cryſtalline maſs, very ſmooth, ſoft, and fuſible between the fingers, which keeps for a great length of time. This operation is principally performed in the laboratories of Pharmacy and the perfumers' work-ſhops with the fat of pork, which is in this ſtate called lard or *axungia*. The fat thus purified is more opaque, leſs denſe, and much whiter than in its natural ſtate: it retains between its molecules a certain quantity of water which gives it theſe new characters.

7. Fat expofed to a mild fire is liquified, becomes tranfparent, and fixes into fmall, clofe and granulated cryftals by cooling. Its fufion takes place between forty and feventy degrees of the centigradal thermometer, according to the different varieties of this animal matter. It may be melted in balneo mariæ, in order to avoid its alteration when we wifh only to effect its fufion. Heated in contact with the air beyond the heat requifite for fufing it, it quickly acquires a temperature fuperior to that of boiling water; it becomes capable of baking and drying the vegetable and animal matters that are immerfed in it, which are drawn out of it hardened at their furface and deprived of water. Soon afterwards there arifes from it acrid and pungent vapours, which excite a difcharge of tears, and irritate the fauces. This fmoke inflames, and the fat continues to burn till it is reduced into coal. We fee by this that it does not burn till after it has been volatilized, and that it is in order to reduce it into vapour that, when it is employed for lamps, a wick is ufed for the purpofe of conveying into the air the part which has been reduced to vapour.

Fat diftilled on the water-bath affords a certain quantity of water of a faint fmell, in which the different re-agents produce no alteration, and which neverthelefs becomes turbid, depofits flakes, and acquires a fetid odour when it is kept. This water, however, prefents a lefs fenfible alteration than moft of the other animal fubftances;

ſubſtances; it becomes leſs ammoniacal; and it is in general a very marked character of this ſpecies of humour; that it affords much leſs of the latter product than all the other animal compounds; which has induced chemiſts hitherto to ſay that it was an almoſt vegetable matter, or which paſſed almoſt without change from the vegetable aliment into the body of animals. The water which is obtained in this diſtillation of fat on the water-bath was not intirely contained in this humour; a part is formed at the expenſe of the hidrogen and of the oxigen which it contains: on which account, after this mode of action of the fire, the far is perceptibly drier, and of a fawn-yellow or browniſh colour, which announces its commenced decompoſition and the precipitation of the carbon.

8. When we diſtil fat in a retort, we effect its decompoſition in a much more complete manner. This operation has long been performed in the laboratories of chemiſtry: nevertheleſs its real mechaniſm and remarkable phenomena have hitherto been unknown. It has been obſerved, that in this diſtillation the fat paſſed almoſt intire into the receiver when it was heated a little ſtrongly; but there was however diſengaged a ſmall quantity of very acid water, an elaſtic fluid, which Hales reckons to amount to eighteen times the volume of the fat, which was believed to be air, and that there remained a coally mark in the retort. It has

has been ſeen, that by repeated diſtillations of the ſublimed fat, there was each time obtained from it a portion of acid water, an oil which gradually became attenuated, a portion of air, and a light layer of coal: it was thence concluded that by repeating this operation the fat would be converted into the ſtate of water and of air. It reſults from theſe facts, which are now better underſtood, that it is into water and carbonic acid, beſides a ſmall quantity of ammonia, that the fat is reduced completely, and in its laſt analyſis; but that in order to arrive at this complete decompoſition, it is neceſſary to add to this matter when heated a large quantity of oxigen; that it is on this account that the operation advances much faſter in a large veſſel than in a ſmall one, or that we are obliged to repeat the diſtillation a great number of times in ſucceſſion; finally, that this decompoſition reſembles, though in another mode and with other phenomena, the combuſtion of the fat in open veſſels; that when this is performed with care, we have only water and carbonic acid as products; that when it is effected only in part we obtain from it, as in diſtillation, an acid vapour, a portion of oil not decompoſed, but merely volatilized, and a coally, or fungiform concretion of coal, which collects upon the wick, and preſent a new obſtacle to this phenomenon; that thus the products of the diſtillation of the fat in the retort, the phlegm, the ſebacic acid, the gaſes,

gafes, the more or lefs liquid oil, are kinds of compounds intermediate between this body and the water, and carbonic acid, which are the ultimate terms of its decompofition; that their proportion muft vary according to the force of the decompofition that is effected, according to the temperature that is employed, the fize of the veffels, the quantity of air which they contain, the manner in which the fire is managed, &c.

9. Thefe general notions ferve to enable us alfo to conceive and explain what the different chemifts have written concerning the diftillation of fat. Neuman, one of the firft who has well defcribed this operation, diftilled comparatively the fats of the bullock, the fheep, the hog, and the goofe: he employed 1152 parts (grains) or two ounces of each of thefe fats. That of the bullock gave him fixty parts of phlegm or empyreumatic and acrid liquor, of which he has not however indicated the acid nature, 852 parts of oil, and eighteen of coal. From the fat of fheep he obtained ninety parts of phlegm, 854 of oil, and 16 of coal; from that of the hog, 70 parts of phlegm and 880 of oil; and from the fat of the goofe, 60 parts of empyreumatic water, 890 of acrid oil, and 10 of coal. He confidered this coal as earth: he took no account of the elaftic fluids, and he did not know the febacic acid. Hoffmann believed that the product of the diftillation of fat was alkaline, as it turned copper

blue. Segner obtained from four ounces of human fat, heated to 600 degrees of Fahrenheit's thermometer, or 270 of Reaumur, 100 drops of phlegm, the acidity of which he has indicated, as well as Vogel: he has obſerved that this product reddened the blue colour of violets, that its ſtrong odour was obnoxious to the brain: that there remained in the retort, after he had obtained it, a concrete and blackiſh oil.

Crell performed the diſtillation of the human fat in a more careful manner; twenty-eight ounces, heated in a glaſs retort with the ſand-bath, yielded, after having melted at the 115th degree of Reaumur's thermometer, an inſipid phlegm; at 220 degrees, an inflation took place, which did not appear in the fat of the bullock; there were diſengaged two liquids, a brown and liquid oil upon a water of a gold-yellow colour, beſides an oil fixed at the bottom of this water. The operation laſted twenty-one hours: all the products had a ſtrong ſmell. By diſtilling them over again, he obtained twenty ounces, five drachms, forty grains of fluid oil; three ounees, three drachms, thirty grains of acid phlegm; three ounces, one drachm, forty grains of brilliant coal, five drachms, ten grains loſs.

We eaſily perceive, in the differences of the proportions between theſe different analyſes, the truth of what I have advanced concerning the varieties of the mode of operating, of the temperature,

perature, of the form and ſize of the veſſels, concerning the rapidity with which the heat is applied, the repetition of the diſtillations, &c.

10. Fat kept in the air becomes the more altered in it the more multiplied the points of contact between them are, and the hotter the atmoſphere is; it acquires a yellow and ſometimes an orange colour; it aſſumes a pungent odour, which is known by the name of a *rancid ſmell*, with an acrid and manifeſtly ſour taſte. This kind of rancidity, which is owing to the development of an acid, ſuppoſes alſo the fixation of a portion of oxigen; it appears that it proceeds from a fermentation which eſtabliſhes itſelf in the gelatinous ſubſtance, which accompanies even the purified fat, which re-acts upon the adipoſe ſubſtance itſelf, which developes in the latter ſebacic acid, and perhaps a ſmall quantity of acetous acid in the firſt. The water in which rancid fat is waſhed acquires an acrid taſte, and the property of reddening the blue vegetable colours. Mr. Poerner employed this liquid in order to purify it. Alcohol equally poſſeſſes this property, according to Citizen Machy. However, both of theſe agents diſſolve a part of the fat at the ſame time with its acid, and the fat, though well waſhed, retains a portion of the latter. Theſe obſervations already prove that the ſebacic acid, developed in the ranceſcence of the fat, was not contained ready formed in this ſubſtance, but that it is formed by the fermentation itſelf which

which it has undergone. However little rancid the fat may be, we see that it acquires properties very different from those which it possessed previous to this rancidity, and which it must however have in part, at least, if it naturally contained sebacic acid ready formed.

11. Fat mixes very well with sulphur by simple trituration; it dissolves it with the aid of fusion, and assumes a pretty strong consistence by this union, which forms the sulphurated ointment. When we heat this sulphurated fat, we do not obtain from it any sublimed fat, but a large quantity of sulphurated hidrogen gas and of sulphureous acid, because a high temperature, by favouring the decomposition of the fat, transfers a portion of its oxigen to the sulphur, which it burns in part, and of its hidrogen to the same body which it carries off in the gaseous form.

The case is the same with phosphorus, which is dissolved very easily in the heat by melted fat. It is difficult to separate the phosphorus from this combination: it is, however, not so much fixed in it as the sulphur; but it is also disengaged from it by the action of heat in the state of phosphorated hidrogen gas. In performing this experiment, it is necessary to employ precautions in order to prevent the detonation and sudden inflammation which may be produced by the phosporated compound.

Fat acts even in the cold upon some metals, the oxidation of which it effects, or at least favours,

favours, when it is triturated with theſe bodies reduced into ſmall particles, and in contact with the air. This effect is particularly perceptible in the preparation of the mercurial ointment, which conſiſts in triturating running mercury with hog's lard. We ſee this metal gradually loſe its metallic form and liquidity, and the fat acquire a black colour. Though in this extinction it was at firſt thought that the mercury was only divided, as we always ſee metallic globules in the beſt prepared ointment, it is certain that it is a real black oxidation of the metal, becauſe it takes place much more ſpeedily when we add to the fat red oxide of mercury, ſuper-oxigenated muriate of mercury, or when, inſtead of ſimple lard, we take oxigenated fat, as I ſhall indicate hereafter, when we aid this extinction by highly oxigenated animal matters, ſuch as ſaliva. The fat acts in the ſame manner upon copper, which it very quickly converts into green oxide. This phenomenon is very perceptible with wax, which indeed is one of the moſt highly oxigenated adipoſe ſubſtances.

12. Water does not diſſolve fat, and when we employ it in order to waſh and purify it, it is only in order to ſeparate from the blood and other ſoluble matters which it contains. When fat is boiled in water it melts, and the aqueous liquor then diſſolves the membranous laminæ, and the cellular texture which are interpoſed in it; ſo that if the water be in ſmall quantity,

and

and we afterwards ſuffer it to cool, it concretes into a jelly. I have already ſaid, that a portion of this liquid is interpoſed between the molecules of the fat: ſo that after the cooling and condenſation of the latter, it is in a granulated form, more light, white, and opaque than it was before. It is neceſſary to heat it afterwards for a long time, in order to ſeparate from it this portion of water, which eſcapes with a crackling noiſe till the laſt particle. Another effect is produced by the water when the fat is boiling and violently heated, when it is on the point of being inflamed, and eſpecially when it is ſo already. Water thrown upon fat thus heated frequently produces a conſiderable exploſion, and greatly augments its inflammation, which is owing to a real decompoſition of the water effected by the red-hot carbon, and the rapid diſengagement of the carbonic acid, and of the hidrogen gas, which are the product of this decompoſition. On this account water, ſo far from being able to ſtop the burning of inflamed oils and fats, only gives greater activity to the combuſtion, and augments its ravages.

13. Fat acts, with the aid of heat, upon all the metallic oxides, and reduces them at firſt by becoming itſelf oxigenated, and afterwards by being decompoſed. This effect is obſerved in the preparation of ointments and plaſters. It is the ſame as that which I have deſcribed in the hiſtory of the oils. Many metallic oxides,

oxides, especially those of lead, copper, and iron, are soluble in hot fat; they give it consistence and heat; they form with it kinds of insoluble soaps; it is therefore dangerous to melt fat in earthen vessels glazed with the oxides of lead and of copper.

The powerful acids, and especially the sulphuric and the nitric, act in a very remarkable manner upon fat, whilst the weak and little decomposable acids, or those which yield their oxigen with difficulty, do not cause it to undergo any alteration.

The concentrated sulphuric acid turns fat brown, and reduces it to coal in a perceptible manner in the cold: its action stops when it has formed in it a sufficient quantity of water to be saturated with it. In the heat it goes much farther; there are disengaged sulphurous acid gas, carbonic acid gas, and sulphurated hidrogen gas. The fat is afterwards in a great measure decomposed, and there remains of it only a small black portion having little consistence.

The nitric acid acts but very little in the cold upon the adipose compound. In the heat, at the temperature at which the fat melts, nitric acid, at 32 degrees of the aërometer, is decomposed, yields oxigen to it, gives it an orange-yellow colour; there is disengaged a small quantity of nitrous gas, and azotic gas; it is in this manner that we obtain the oxigenated ointment, which I first proposed several years ago, to be substituted instead of the unguentum

citrinum, and which Citizen Alyon has ſince found ſo uſeful in the itch, in old herpetic eruptions, and in veneteal affections of the ſkin. He prepares it by taking fifteen parts of fat, and one part of the acid indicated, by cauſing them to act at a mild heat till an ebullition takes place, by withdrawing the mixture from the fire, and by agitating it conſiderably whilſt it is cooling. There may be many degrees of the oxigenation of the fat, according to the form and the quantity of the acid which is employed. If we employ three or four parts of nitrous acid to one of fat, and heat it ſtrongly, we decompoſe theſe two bodies; the fat becomes ſenſibly brown, ſebacic acid and a little oxalic acid are formed, whilſt much nitrous gas and carbonic acid are diſengaged, without mentioning the water which is diſengaged at the ſame time. Amongſt the different oxidations which the fat is made to undergo by treating it by this acid, of different ſtrengths, at different temperatures, and in varied doſes, there is one which approaches ſo near to the dryneſs of wax, that there is reaſon to hope we ſhall at ſome future period, be able to give it this character in our manufactures. The fat oxigenated to the ſtate of ointment or pomatum extinguiſhes mercury five times faſter than natural fat, and may ſerve with great advantage for the preparation of the *unguentum citrinum:* it is alſo ſuſceptible of quickly oxiding copper, which it diſſolves with the aid of heat, and with which it ſoon forms a ſort

ſort of brown ointment; it is ſoluble in alcohol, &c. We may oxigenate fat by means of the oxigenated muriatic acid.

14. The cauſtic alkalis have a very ſtrong action upon fat; they eaſily reduce it to the ſaponaceous ſtate. This kind of animal ſoap may ſerve for all the purpoſes of economy, and it is manufactured of this kind in ſome countries. Ammonia does not exert any ſuch action upon the adipoſe compound. Lime, barites, and ſtrontian, combine with it, and conſtitute earthy, hard, ſolid, and inſoluble ſoaps. Theſe compoſitions are ſometimes employed in the fabrication of mortars or cements, and they give them a conſiderable ſolidity, and the property of receiving a ſoft and unctuous poliſh. The ſoaps of fat, when burned by a violent fire, are reduced to coal and afford alkaline and earthy ſebates, which ſome modern chemiſts have believed to be all formed in the original ſoaps, but which are really formed only by the high temperature which burn and decompoſes the fat. I ſhall ſoon ſpeak of them again in treating of the ſebacic acid. The ſalts have no action that is known upon fat; the muriate of ſoda preſerves it, and keeps it for a conſiderable length of time from becoming rancid.

15. The metallic ſalts and ſolutions exerciſe in the heat upon melted fat, an action which has long been known in the laboratories of pharmacy, where ſeveral compoſitions of ointments or plaſters, are prepared with theſe matters: it is eſpecially exemplified with the nitrate of

mercury

mercury in ſolution. When we pour this ſolution into melted fat, and agitate the liquid, there is ſuddenly formed a yellow precipitate, and the mixture, as it cools, aſſumes a ſolid conſiſtence, preſerving its colour; on which account it has been called the citron-ointment. The oxide of mercury in this compoſition quits the nitric acid, and paſſes into the ſtate of yellow oxide; the fat is oxigenated by the acid, and itſelf aſſumes a ſimilar tinge. We ſee azotic gas diſengaged in ſmall bubbles. All the metallic nitrates, and moſt of the ſalts and acid ſolutions of the metals, preſent either a ſolution or a decompoſition by melted fat. Several of them even unite well with it in the cold and by ſimple trituration. This kind of combination which as yet is little known, and the reciprocal action which accompanies it, deſerve to engage the attention of the chemiſts, and muſt afford, by new reſearches, uſeful matters to the arts, as well as new reſults to the theory of the ſcience.

16. Fat combines with a great number of vegetable and animal ſubſtances: it eaſily diſſolves the extracts, the green colouring parts, the balſams, the reſins, and the gum-reſins, as we ſee in the preparation of a multitude of ointments and plaiſters; it obſtinately retains all the odorous materials of thoſe bodies, as is proved in the art of perfumery; it ſtops the alteration of which theſe ſubſtances are ſuſceptible and preſerves them for a great length of

time;

time; it unites with elaſtic reſin though with difficulty. Alcohol has no action upon it, at leaſt unleſs it be rancid or oxigenated; however, ſome ſpecies of adipoſe ſubſtances, amongſt thoſe which naturally contain the moſt oxigen are capable of diſſolving in it. The mucilages combine with melted fat, and communicate to it that kind of ſoftneſs and unctuoſity which characterizes ſome ointments. The gums triturated with fat render it ſoluble, or at leaſt capable of remaining ſuſpended in water. It is capable of uniting by fuſion with the oils, to which it communicates a part of its conſiſtence. Tannin appears alſo to be ſuſceptible of combining with fat, though this kind of combination has not yet been ſpoken of. Finally, the albuminous animal liquors unite alſo with it by long trituration, and it is through their mediation that the fat is taken up again by the abſorbent veſſels and carried back into the circulation. Haller has obſerved that ſome purulent humours, which are only a compound analogous to thoſe which I here indicate, have the fatty character and inflame when they are heated.

17. I have announced, in ſeveral of the preceding articles, that fat affords, by its decompoſition by fire, a particular acid, which has been called *ſebacic acid,* as it is obtained in conſiderable abundance from tallow. This product deſerves a particular deſcription. Crell has occupied himſelf the moſt with this ſubject of all the chemiſts. After having found that

 it

it was constantly disengaged during the decomposition of fats by fire, he endeavoured to find the means of purifying it; but he met with great difficulty to separate the oil which accompanies it. Having employed distillation with the view to concentrate it, he obtained a very acid water, and was convinced that it was more volatile than this liquid. He saturated the acid product of fat with pot-ash, evaporated the liquor to dryness, and heated the residuum in a crucible till it afforded no more smoke; and till it dissolved without colour, by precipitating carbon during its solution in water. This second solution being evaporated afforded him a foliated salt which he distilled with half its weight of sulphuric acid, and he thus obtained a fuming acrid acid, in the proportion of one-twentieth part of the salt employed. When this salt had not been sufficiently calcined it gave him by the sulphuric acid an oily liquid of a gold-yellow colour mixed with the acid liquid. He employed an ordinary copper alembic for distilling the fat and obtaining from it the acid liquid, as well as the fluid oil; but this process did not answer his purpose; the acid retained copper, and the tinning of the capital was melted; he therefore endeavoured to find another process than the distillation and the saturation of the product of the fat by the fixed alkali in order to procure the sebacic acid. The following is that which he adopted after many attempts.

18. Per-

18. Persuaded, with all the chemists, and especially Cartheuser, Macquer, &c. that the sebacic acid existed ready formed in fat, he proposed to fix it by means of the alkalis immediately and independent of distillation. He made a soap of fat with pot-ash, of which he mixed ten pounds in a gelatinous state with 22 ounces of dissolved alum; by separating the liquor from the precipitate formed by the insoluble aluminous soap, and evaporating it, he extracted from it twenty one ounces of sebate of pot-ash, mixed with sulphate of the same base. It was from this salt distilled with the sulphuric acid that he extracted the sebacic acid; he rectified it upon a quarter of the salt preserved for this purpose. He assured himself that this rectified acid contained no sulphuric acid by trying it with the acetite of lead; the precipitate which he obtained ought to dissolve entirely in vinegar if it was only sebate of lead, and not dissolve intirely in it if it were mixed with sulphate of lead.

Citizen Guyton has described another more easy and more simple means for obtaining the sebacic acid. This means consists in treating the fat with quick lime, by mixing this caustic earth in powder with melted fat; the mixture is left to cool, the soap is washed with a large quantity of water, the ley is filtrated and evaporated; the brown calcareous sebate which is the product is strongly calcined in a crucible, then lixiviated, the solution filtrated, the

ſuper-abundant lime is ſeparated from it by the carbonic acid, and it is afterwards evaporated by diſtilling the white and pure calcareous ſebate which it affords with ſulphuric acid, pure ſebacic acid is obtained. It appears evident to me, thathere, as in all the proceeding caſes, the ſebacic acid is the product of the great alteration which the fat ſuffers from the fire, that it is not contained ready formed in the fat, and that the calcinations to which the alkalis and the lime, as well as the fat, are ſubjected, when under pretence of purifying the ſalt it is very briſkly heated, are the true cauſes and at the ſame time the proofs of the formation of the ſebacic acid. In my opinion it is neither a ſebate of pot-aſh nor a ſebate of lime: it is not a ſalt but a real adipoſe ſoap which is heated, and which then leaving the animal oil to be decompoſed, preſents the earthy or alkaline ſubſtance to abſorb and fix the portion of ſebacic acid which is formed. No fact proves that pure fat contains this acid; it is only by a conjectural theory that it is admitted, whilſt on the contrary, every thing proves that in order to prepare it, it is neceſſary to decompoſe the fat and combine its conſtituent principles in another order.

19. Crell extracted ſebacic acid to the amount of a little leſs than one fourth of the fat, by treating it according to the proceſs that has been deſcribed. By examining this acid by different means, he began to imagine that it was the ſame

as the muriatic, becaufe it had given him with foda a falt fufible without decompofition by fire, and it acts upon gold with the aid of the nitric acid, precipitates the nitrate of filver, fublimes with mercury, and its folution is not decompofed by the muriate of foda, and becaufe its combination with antimony is precipitated by water. But Citizen Guyton on comparing this febacic acid with the muriatic acid under other relations, has found more differences than refemblances between them; he has befides judicioufly obferved, that a fingle chemical property conftitutes a fufficient difference between them to prevent their ever being confounded together. According to him, the febacic acid combined with foda cryftallizes in needles, not in cubes like the muriate of foda; it forms no deliquefcent falt with iron; it attacks running mercury; it precipitates the oxigenated muriate of mercury, as well as the muriate of foda, the bafe of which it retains whilft it difengages its acid by diftillation; laftly, alum is not decompofed by the febate of lime, which is alfo one of the moft diftinguifhing characters of this acid. According to thefe principal differences, Citizen Guyton does not hefitate to confider it as a particular acid different from all thofe that are hitherto known.

20. The febacic acid appears to be formed generally by the decompofition of all the oily bodies, fince Mr. Crell obtained it by diftilling butter of Cacao; however it is more eafily

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and more abundantly produced by all the fats; thus the German chemiſt whom I have mentioned has extracted it eſpecially from ſpermaceti. Though the intimate nature of the ſebacic acid, has not yet been determined, what we known of its formation permit us to ſuſpect that it is not, like the Pruſſic and zoonic acids, a real animal product, or compound of a triple radical of hidrogen, carbon and azote, all united with oxigen. Of whatever nature it may be, the following are properties which diſtinguiſh and characterize it. It has an acrid ſuffocating odour, which irritates the eyes, the noſtrils and the throat, by which it is eaſily recognizable. It exhales a white vapour or ſmoke when it is well concentrated; it reſembles in its conſiſtence and aſpect an oily liquor, whence its origin is rendered apparent to the eye. It ſtrongly reddens the tincture of turnſole, and perceptibly even that of violets. It is very volatile, aſſumes a reddiſh colour by the action of fire, and leaves at each diſtillation employed for rectifying it, a brown liquid, or a coally trace when the operation is carried on to dryneſs. It is entirely decompoſed in a red hot tube, and converted into water, carbonic acid, carbonated hidrogen gas and coal.

21. Its combinations with the alkaline and earthy baſes, or the ſebates, have traits of reſemblance with the acetites according to Bergman; Citizen Guyton however obſerves, that they are more fixed in the fire and leſs alterable

alterable by the air. The ſpecies of theſe ſalts have not yet been well deſcribed; we only know that moſt of them are cryſtallizable in laminæ, conſiderably ſoluble, decompoſable by the ſulphuric acid; it alſo appears that the order of the attractions of the ſebacic acid for the baſes, preſents ſucceſſively barites, pot-aſh, ſoda, ſtrontian, lime, magneſia, glucine, alumine and zircon, like moſt of the powerful acids, eſpecially the ſulphuric, nitric and muriatic. Some remarkable facts have been collected relative to the attractions of ſeveral of the ſebates. The ſolution of ſebate of lime does not render that of alum turbid, which proceeds from the weak attraction of the ſebacic acid for alumine. This acid, diſtilled with the alkaline ſulphates, diſengages from them ſulphureous acid whilſt it becomes decompoſed. It precipitates the ſolution of tartrite of pot-aſh in tartareous acidule. It decompoſes the nitrate and the acetite of pot-aſh by diſtillation, but it does not attack the muriate of ſoda. It appears to be capable of attacking glaſs and diſſolving a part of it, as it deprives the veſſels in which it is diſtilled of their poliſh, and afterwards depoſits by digeſtion ſiliceous earth. The ſame effect has been ſeen in the pyromucous acids.

22. The ſebacic acid exerts a ſufficiently marked action upon many metallic ſubſtances. Diſtilled upon the arſenious acid it reduces it into metal, as is alſo done by the entire oil and

fat.

fat. It does not attack either cobalt, bismuth or nickel, even by long continued digestion. It precipitates the nitro-muriatic solution of antimony, which in fact is decomposed by water alone in very large quantity. It combines with mercury and silver, when it is brought to act upon these two bodies in the metallic state. The sebate of silver is precipitated by the muriatic acids, whereas the sebacic acid decomposes the nitrates of mercury and of silver, the sulphate of the latter, and even precipitates the solution of oxigenated muriate of mercury in a white powder. It equally precipitates the nitrate and acetite of lead, but not the sulphates and nitrates of zinc, of iron and of copper. It attacks gold very feebly, but it dissolves it very well when it is combined with the nitric acid. This is one of the facts which chiefly led Mr. Crell to infer a great analogy between this acid and the muriatic. Combined with the oxide of gold, the sebacic acid forms a crystallizable salt, as well as with the oxide of platina; it precipitates both from their nitro-muriatic solutions.

The German chemist, disposed according to all his experiments, to rank the sebacic acid amongst the most powerful of these bodies, announces that it acts even upon the oils, which appears to depend upon its oily nature, and that he has succeeded in obtaining ether by treating alcohol with this acid.

23. I have described all the known chemical properties

properties of fat in general; I must now give an account of the differences which it presents, as well with respect to the different regions which it occupies in the same animal, as with respect to the age of the animal, the different orders of animals, and lastly, in its morbid alterations.

The variety of the characters which fat presents, according to the different regions in which it is considered, is a fact well known to anatomists. It is more solid under the skin and in the vicinity of the kidneys; it is less so, and it even runs like an oil, between the muscular fibres, or in the vicinity of the moveable viscera, such as the heart, the stomach and the intestines. It has a granulated character round the articulations, and in the interior of the corticular capsules. Haller has found it almost as hard as a calculus, or what is so improperly called a *stone of the bladder*, within the leg and along the internal osseous surface of the tibia.

24. Age causes the fat to vary very sensibly. Haller found none of it in the epiploon of a fœtus of four months. According to Ruysch and Diemerbroeck, instead of real fat, there is only a kind of tremulous and gluey jelly under the skin of the fœtus; afterwards there is formed a small quantity of granulated fat. This humour augments rapidly after birth; in the first year of life the human body is extremely fat; the fat under the skin is for a long time white; it grows yellow with age: it is ex-

tremely

tremely soft in the female sex. At the age of forty years, its quantity exceeds that which it has at any other period of life. This period is that of a real adipose cachexy. At the commencement of old age it melts, and suffers the skin which till then it had supported in a state of tension, to collapse as it were into a faded and wrinkled condition. The small quantity of fat which remains in old men is hard, consistent, of a deep yellow colour, sometimes approaching to a brown. The same adipose phases take place in animals as in man: they however vary with them according to their nature, the state of their blood, and the mode of their respiration.

25. The fat of the mammalia in general does not differ much from that of the human species. It has been observed that in the frugivorous and herbivorous animals it is more firm and more solid than in the carnivorous. It is to the first that the lard and tallow particularly belong. Spermaceti is a kind of fat which is extracted from the head and the spinal canal of the cacholot, and which is characterized by a dry and friable adipocerous consistence, by a crystalline, lamellated and brilliant form, by its fusibility inferior to that of ordinary fat, and by its solubility in alcohol. Of this I shall speak more hereafter in detail. I here consider it in general, because this fatty substance is found in many other animal matters besides the head of that species of whale.

2 The

The fat of birds is fine; mild, unctuous, and very fusible. In fishes it is almost fluid or oily: it deposits adipocire.

It exists in insects, worms, and the testacea; in these it especially accompanies the viscera of the abdomen, where it is placed in small lumps: it is also found, though more rarely, under their skin.

26. Diseases have an influence upon the fat; it is itself sometimes the cause of maladies. Its abundance constitutes a morbific affection; it has been known to augment the average weight of a man, which amounts to 80 kilogrammes, to 300. It sometimes presses the heart, and retards and even stops its motion; it obtunds the nervous sensibility; it disorganizes the muscles; sometimes their fibres are found converted into fat; it melts in most diseases, and seems to serve as nourishment during the torpid state of men and animals: thus the dormouse, the marmot, &c. go into their holes very fat, and come out very meagre after the hibernation. After diseases, especially of the febrile kind, man is extremely meagre; much time is not required for the fat to be formed again. Some small birds become extremely fat during a single night when there is much fog. It assumes a yellow or green colour from the admixture of bile, which appears to have much relation with fat. It is sometimes seen to flow off with the excrements in diseases. When the external part of the body of animals is

is made to grow lean by extreme heat, it is obſerved that their liver increaſes conſiderably in ſize. We ſhall ſoon ſee that this viſcus is in fact of an adipoſe nature.

27. Fat fulfils a great number of uſes in the life of animals; it maintains the heat of the parts by preventing the caloric, of which it is a bad conductor, to be diſengaged outwardly; it is known that fat perſons are leſs ſenſible to cold than lean ones. Galen mentions a perſon who always felt cold in the abdomen after having loſt a part of the epiploon by a diſeaſe. Macquer thought that it ſerves to abſorb the ſuper-abundant acids of the body of animals; but he founded this idea upon the concrete ſtate of the fat, which he believed to be owing to a combination of acid, and it is now known to be an error. This ſubſtance appears rather to abſorb the ſuper-abundance of hidrogen, and to be formed when the oxigenation is too little conſiderable. By its unctuous quality, fat facilitates the ſliding of the parts upon one another; it prevents the fibres from being glued together. It determines the rounded, graceful, and ſoft forms of ſeveral parts: it diſtends and ſupports the ſkin, at the ſame time imparting whiteneſs to it; it fills up vacuities and intervals between many fibres, textures, or organs. It renders the bones flexible and pliant; it paſſes from one part into another with much facility; it is abſorbed by the lymph, which renders it ſoluble; it in part nouriſhes animals, who

who thus ſupport themſelves upon their own ſubſtance at their own expenſe.

28. Fat is employed for a great number of economical uſes. It not only ſerves as ſeaſoning to a great number of aliments, to which it communicates a mild unctuous quality; but it alſo is itſelf an aliment, and has very decided advantages in caſes of a too high oxigenation of the ſyſtem. It may therefore be adminiſtered in medicine, not only as has hitherto been done, as a lubrefacient, emollient, relaxant, and lenitive remedy, but alſo as a diſoxigenating medicine, or one which abſorbs that ſuper-abundance of oxigen, which manifeſtly, exiſts in inflammatory diſeaſes.

The numerous uſes are ſufficiently known to which it is applied in currying leather, in facilitating the motion of machines, in plaſters, in ſome mortars, &c. Every fat has, as is well known, its particular utilities.

Article V.

Of the Tranſpiration, of Sweat, and of the Humour of the internal Cavities.

1. THE inſenſible tranſpiration (a word which is ſometimes taken for the matter which iſſues in the form of vapour from the ſurface of the ſkin, and ſometimes for the function itſelf by

by which this exhalation is effected) is one of the evacuations with which physicians have been the most occupied, and of which physiologists have not perhaps availed themselves so much as the former have done for the theory and practice of their art. There is no phenomenon in animal life which has given rise to more researches and explanations, or which has excited so much interest amongst philosophers. It was known by Hippocrates, Theophrastus Erasistratus, and Asclepiades, who called it *pneuma*, because they knew that it had the form of air. Galen has made it one of the bases of the pathological etiology. Sanctorius acquired, at the commencement of the seventeenth century, an immortal reputation by publishing the result of his long experiments upon transpiration, and the exposition of its influence upon health and diseases. His Medicina Statica, published in 1614, does not however contain the detail or the description of his experiments, but only aphorisms of which we do not always see the relation with the experiments themselves, as these remain unknown; but at that period natural philosophy did not exist; and too little attention was then paid to experiments for it to be thought necessary to present their detail, and an account of the manner in which they were conducted to the readers.

2. Towards the end of the same century, in 1668, Dodart, a physician, and member of the Academy

Academy of Sciences of Paris, which had juſt been eſtabliſhed in 1668, communicated to it his reſearches upon tranſpiration: he contented himſelf, like Sanctorius, with giving reſults, and comparing them with thoſe of Sanctorius, in order to determine the differences preſented in this reſpect by the climate of Paris, ſituated at forty-nine degrees of latitude, compared with that of Venice, at forty-nine degrees, where Sanctorius had made his. J. Reil repeated ſimilar experiments during ten years at Northampton, ſituated at fifty degrees, and he was the firſt who publiſhed the detailed journal of them. Bryan Robinſon did the ſame in Ireland; G. Rye at Cork, and Linings in South Carolina, at thirty-three degrees of latitude. When we compare thoſe labours of more than a hundred years, which have not been continued during nearly ſixty years paſt, though this kind of reſearch promiſes, eſpecially for the laſt thirty years, many more important reſults than could have been formerly obtained, on account of the more advanced ſtate of the ſcience, we find unfortunately, together with ſome general truths, much uncertainty, contradiction, and error. Haller ſhows, in his great work of Phyſiology, that the authors of theſe experiments have not taken all the poſſible precautions, that they have neglected both the ſaliva and the pulmonary abſorption. He reproaches Sanctorius himſelf, who however has acquired ſo much fame, and who will always deſerve it in the memory of mankind,

mankind, for having first made experiments, for having first conceived the idea of measuring the quantity of the transpiration by weight, and of placing the medical theory upon a sure foundation; he reproaches him, I say, for having allowed too much to the transpiration, and for having forced the results in order to adapt them to the Galenic theory of which he was a follower.

3. In modern times I find only Lavoisier and Seguin, who, having associated together in order to examine the phenomena of transpiration, contrived to measure in particular and separate from each other, by means both ingenious and exact, that which takes place in the lungs, and that which is effected by the skin, and to compare their relative quantity. We owe to them some important results; but only in a general way. Their researches, of some hours or some days only, do not present the long series of those of Sanctorius, of Dodard, of Kiel, of G. Rye, or of Robinson, though they are far superior to them in accuracy and precision. The French philosophers have described with much care the means and the instruments which they have employed for making their experiments; and hence we may judge of the difference between them and those of the physiologists who had preceded them in this career. Most frequently Citizen Seguin himself was the subject of these experiments. The balance which he employed, the beam of

of which was four feet and a half in length, was fo accurate, that when charged with 125 pounds or 62½ kilogrammes on each fide, it was turned by a weight of two grammes, or half a drachm (gros). He placed and inclofed his whole body in a fack of varnifhed filk, which having been blown up with air, had loft nothing during fifteen days. This fack was tied clofe above his head: it had an aperture which was accurately glued round his mouth with a mixture of turpentine and pitch. The mouth being thus open, and communicating with the atmofphere, the pulmonary tranfpiration paffed into the air, and that of the reft of the fkin collected in the fack, which let nothing efcape. By weighing himfelf twice at certain intervals of three or four hours, he found the weight of the pulmonary perfpiration in the diminution which the balance gave him; by afterwards weighing himfelf in the fack likewife at certain intervals, and twice in fucceffion, he had the weight of the cutaneous tranfpiration by fubtracting from the total lofs that which he had found by the pulmonary tranfpiration, and always comparing the aliments and excrements with the lofs in invifible effluvia. Hitherto in thefe experiments means were not fought for afcertaining the nature of the tranfpired fluid, and only the determination of its quantity was had in view. I fhall fhow elfewhere by what ingenious machines the fame modern philo-

 fophers,

sophers, Lavoisier and Seguin, have succeeded in carefully analyzing the phenomena of respiration.

4. Though the results obtained by these different experiments have pretty considerable differences from one another, without presenting them in all their details, as Haller has done in his great work, it is necessary at least to indicate the general results. In the northern countries, and according to the experiments of G. Rye, during the three winter months, there pass out of the body 4797 ounces of perspiration, and 3937 of urine; during the three spring months, 5405 ounces of perspiration, and 3558 of urine; in the three summer months, 5719 ounces of perspiration, and 3352 of urine; finally, in the three autumnal months, 4471 of perspiration, and 3369 of urine. In a day of the winter there are, according to the same experiments, 53 ounces of perspiration, and 42 of urine; in a day of the spring, 60 ounces of perspiration, and 40 of urine; in a day of the summer, 63 ounces of perspiration, and 37 of urine; finally, in a day of the autumn, 50 ounces of perspiration, and 37 of urine.

According to the results of Keil, there are 31 ounces of perspiration, and 38 of urine, so that the latter exceeds the former.

Dodart had found that the proportion of the transpiration to that of the solid excrements, was as 7 to 1, and to all the sensible excrements in

in general as 15 to 12. The medium quantity of perſpiration in France was, according to him, an ounce an hour.

Robinſon eſtimated, according to his experiments, that in youth the perſpiration was to the urine as 1340 to 1000, and in old age as 967 to 1000.

Hartman obtained, in analogous experiments, the following reſult: from 80 parts (ounces) of aliments eſcape by perſpiration 35, by urine 28, and by the ſolid excrements ſeven. According to Gorter, the proportion of theſe relations is ſuch, that of 93 parts of aliment 49 paſs by the ſkin, 36 by the urine, and eight in the ſolid excrements. We ſee, therefore, that there are differences between the reſults of all theſe experiments made in cold countries.

5. The reſearches upon the perſpiration in warm climates preſent almoſt an equal number of uncertainties and differences, though the experiments being leſs numerous afford reſults more eaſy to be brought to agree with each other. We are indebted for them chiefly to Sanctorius. He made them during nearly thirty years at Venice, where the air is hot and moiſt. His general concluſion is that from eight pounds of food taken in twenty four hours, five are diſſipated by tranſpiration, and only three paſs off by urine and the excrements. In this it agrees with thoſe of the preceding authors which belong to the hot ſeaſon. In the exceſs

of the perſpiration over the ſenſible excrements. Arbuthnot has confirmed them in the ſummer in England. Linings, who repeated them in South Carolina, likewiſe found that in ſummer the quantity of the perſpiration exceeded that of the ſenſible excrements. Many moderns have queſtioned the reſults of Sanctorius, and have thought that they were manifeſtly carried too high. Haller concludes, from all the experiments made by the different philoſophers who have been quoted, compared with each other, that it is doubtful whether the perſpiration exceed in quantity that of the urine, if we take the average of all the reſults which they have obtained ; and that they all differ eſpecially from thoſe of Sanctorius by much ſmaller quantities.

6. We ſhall ſee by the reſults which we owe to the laſt experiments of Lavoiſier and Seguin, that they have frequently obſerved phenomena analogous to thoſe already indicated : but that they have alſo ſeen ſome that are new and different. The following are the inferences which they have obtained from their reſearches.

a. Every four and twenty hours the body returns to the ſame weight when the ſubject is in health and when he is not in the progreſs of growing fat.

b. Bad digeſtion retards perſpiration. He increaſes in weight during four days ; and on the fifth he generally returns to the primitive weight

weight. Sometimes the equilibrium is re-establifhed rather by the augmentation of the excrements than by that of the perfpiration.

c. Drink only, and not the folid aliments, increafes perfpiration.

d. The perfpiration is at it its *minimium* during meals and immediately after them: it attains its *maximium* during digeftion.

e. The maximum is 32 grains a minute, or 25 hectogrammes in twenty four hours; the minimum is 11 grains a minute.

f. The perfpiration is in the compound ratio of the force of the exhaling veffels and of the diffolvent quality of the air.

g. The pulmonary perfpiration is more confiderable, relatively to the furface of the lungs than the cutaneous perfpiration is in proportion to the furface of the fkin. It is ftill more confiderable in the winter, on account of the neceffity of keeping up the temperature of the body at thirty two centigrade degrees.

7. Though the proportion of the perfpiration is one of the moft important objects to Phyfiology and medicine, there is a fecond which is alfo of importance and belongs more to the province of Chemiftry; namely, the knowledge of the matter which iffues in this manner out of the pores of the fkin. But few refearches have hitherto been made upon this fubject. and it is one of thofe with which Phyfiologifts have leaft occupied themfelves.

Haller

Haller considered as the materials of this evacuation the water reduced into vapour which is frequently visible. Tachenius was the first who collected it, by inclosing his arm in an oiled cloth; but he has not examined its nature. Bonnet, Bellini, Winslow convinced themselves of its emission. Lister by keeping his arm plunged in a cold glass; obtained a saline water from it. Kaw and Gorter have especially insisted upon the water which the contact of the skin deposits upon the surface of Glass, and have remarked that the air speedily dissolves it. To this first substance, this vaporized water accompanied with some salts, Haller added the electric matter, the ejection of which he thought to prove by the sparks, the smell, the decrepitation, which have so often been observed in the cloaths at the moment when they have been taken from the body, and in the frictions applied to the hairs of cats; but it is evident that he has confounded the electric effects produced by friction with a pretended electric emanation which nothing proves to take place. The same physiologist also ranked amongst the elements of the perspiration :

a. Fetid volatile parts which he said were the most dense and to which he attributed the traces followed by the venatory animals.

b. Particles of drink and aliment, proved by the smell. On this occasion he refers to the result obtained by G. Rye; namely, that from

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two pounds and four ounces of aliment, only four ounces paſſed off by the excrements and two pounds by the ſkin.

8. The new chemical data and a more profound examination of the perſpiration have led to the diſcovery of ſomething more in it than what had been admitted by the illuſtrious Haller. It is not true that there paſs off through the ſkin, as ſome moderns have thought, elaſtic fluids and eſpecially carbonic acid gas; but there is reaſon to believe that at the ſurface the neareſt to the ſkin, namely in its immediate cavities there is diſengaged and burned a portion of carbon; perhaps even a certain quantity of carbonated hidrogen exhales through its pores and experiences a ſlow combuſtion. This we ſhould eſpecially be led to believe by obſerving that the ſkin, expoſed immediately to the air, and not covered with clothes, aſſumes a fawn or brown colour which ſeems to announce the fixation of a greater quantity of carbon; perhaps even it is this phenomenon in a highly exalted ſtate with the negroes, which colours their mucous texture and the interior ſurface of their epidermis. It is known that they are not born with this colour, but that it is formed, or at leaſt grows conſiderably darker by the progreſs of life.

There is no doubt that water ready formed paſſes off through the ſkin and that it conſtitutes the greater part of the perſpiratory vapour. Citizen Berthollet has ſometimes found an acid

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in it, and he has even discovered in it the phosphoric acid. If this acid were discharged regularly and constantly, it must necessarily accumulate upon the skin, for it is not volatile even with the aid of the vaporized water.

9. The matter of the sweat has been thought to be analogous to that of perspiration; and it has been believed that it differed from it only in not passing off in the form of vapour, and dissolving in the air much more slowly; and though some physiologists have imagined the sweat to be a different substance and even to have its particular organs, we must however admit an identity of nature between these two excrementitious humours. It is known that the sweat is a saline water, a little viscous, in which Lewenhoeck had described globules, and which has been little subjected to analysis; but which Raymond, Bohnius, Lister, and Tachenius have thought to be similar to urine. According to some experiments, Petit has found it to be alkaline and turning the colour of violets green. Frequently it has a sour smell and turns blue paper red. It has been known to stain the linen yellow, green, blue, or black; it is known that it has very various odours, but in general acrid and disagreeable; that it sometimes partakes of that of the aliments; that it is highly odorous and even fetid in animals in heat; that it is sometimes accompanied with fat, with blood, or with bile; that it thickens upon the skin, and leaves upon it a kind of yellowish or brown residuum;

residuum; that it sometimes deposits sandy concretions, or saline crystals which Haller asserts he has seen upon the skin of glass-makers; that it forms upon the skin of the horse a concrete white or yellowish stratum, which Citizen Vauquelin and myself have ascertained to be real phosphate of lime, detached and separated in small scales by the action of the curry-comb; that its quantity varies extremely from some decigrammes only to a kilogramme and a half. Cardan reckoned the quantity of sweat discharged by a patient under a course of mercury at four kilogrammes and a quarter. Continued sweat is always a severe disease, on account of the loss of substance and the debility which it occasions. It is no longer believed with Lewenhoeck that fifteen small drops of insensible perspiration form one drop of sweat, but it is believed that the sweat is the product of the accumulation of the molecules of perspiration which the air cannot carry off.

10. All anatomists now agree with respect to the organs which exhale the perspiration. They think that it issues from the extremities of excessively numerous minute arteries which open under the skin, and which, on account of their extreme tenuity, suffer only the lightest part of the liquid which they contain to pass. They are convinced that it is not from the lymphatic vessels that it proceeds, but that the function of these is opposite to that of exhalation. It will however be observed that since Haller and the physiologists

physiologists who have followed him, in admitting that the perspiration proceeds from the cutaneous arterial extremities, suppose that these small arteries convey only a white and aqueous liquid; they actually admit a second order of vessels which terminate the arteries, and which are the real white vessels of Boerhaave. For the rest, injections violently passed through the arterial cavities, sometimes, though with difficulty, pass out through the cutaneous pores, or diffuse themselves under the epidermis; so that if these injected liquids were sufficiently attenuated, sufficiently hot, and continually pushed forward, they would actually give rise to an artificial perspiration.

11. A kind of consideration which has hitherto been almost foreign to physiologists, which had almost entirely escaped the sagacity of Sanctorius, of which the illustrious Haller himself absolutely says nothing in the long details which he gives concerning the perspiration, which Kauw, in his work upon perspiration has also passed over in silence, and which modern chemistry alone has almost totally drawn into notice, is the influence of the air in the exercise of this function. It is such that perspiration cannot take place without its contact, that it contributes to it in an immediate manner, that it determines its proportion, that it augments it, diminishes it, raises it to its maximum or depresses it to its minimum, that we ought to affirm at present, as Lavoisier and Seguin

first showed with perspicuity, that the perspiration is in the compound ratio of the velocity communicated to the transpiring fluid by the vessels which convey it to the skin, and of the power with which the air dissolves it. We recognize the existence of this solvent property of the air, when we consider with attention what passes at the extremity of the fingers; we there see, especially in the summer, small liquid drops issuing out of the pores situated at the bottom of the elliptrical groves with which this region is streaked, which are soon dissipated in the air and continually renewed, in order to be afterwards taken up and evaporated by the air. The steam rising out of the lungs, from the head, from the hands when taken out of bed, and which we see elevate itself in torrents into the atmosphere, is only the transition of the liquid perspiration to the state of elastic fluid which the air soon gives it; it is necessary therefore, in order that perspiration shall take place, that the air should dissolve it in proportion as it issues out of the cutaneous pores. This solution is accompanied with a refrigeration which every one experiences, and which moderates the heat to which the body is raised under certain circumstances.

12. It must be very evident, according to this exact notion, that supposing the conditions of the perspiration to be the same with respect to the body which perspires, to the temperature, to the motion of the respiration and of the blood,

blood, and to the quantity of perſpirable matter, if the ſolvent quality of the air ſhould happen to vary, variations muſt alſo enſue in the exerciſe of this function. This datum may not only greatly contribute to elucidate the obſervations of Sanctorius, of Keil, of Gorter, of G. Rye, &c. but it muſt alſo introduce important modifications into the notions that have been promulgated reſpecting perſpiration: it may even change a part of the notions that have till the preſent time been conſidered as exact, and in this point of view change the aſpect of the healing art. There is wanting in this reſpect a ſeries of experiments which it is very neceſſary to attempt at the preſent moment; but notwithſtanding this chaſm there are ſome certain principles which are capable of throwing a new light upon the cauſe and nature of diſeaſes, which eſpecially may deſtroy erroneous opinions which have long prevailed. It is evident, after what has been ſaid, that if the air be little charged with moiſture, if it be of a temperature raiſed a little above 15 degrees, for example, if it be frequently renewed at the ſurface of the ſkin by its agitation or its currents, it then combines all the conditions requiſite to its diſſolvent quality; it muſt then take up much water from the ſkin, and the perſpiration muſt be the moſt accelerated and the moſt abundant poſſible. If, on the contrary, the air be hot and moiſt, if it be charged with water to ſuch a degree as to precipitate a part of it, it can take up little or nothing

nothing from the ſkin and the perſpiration muſt be conſiderably diminiſhed or completely ſtopped. This phenomenon frequently takes place in the ſummer, and if it ſucceeds the preceding, the ſkin, which no longer loſes any thing, becomes covered with ſweat, grows ſoft, and the body becomes more heavy.

13. It follows from theſe firſt principles, that when the air in winter, though very low in its temperature, at 10 or 15 deg.—0, is extremely dry, denſe, and agitated; in proportion as it touches the ſkin, it takes from it much caloric, becomes heated at its ſurface, and becomes a ſolvent of water doubly active, both on account of its dry ſtate and of its elevation of temperature; it therefore carries away the more perſpiration the more frequently it is renovated, the more ſwiftly it is moved. Accordingly, in a cold, dry and windy winter, this very highly diſſolvent ſtate of the air, which is perceptible even by the manner in which it evaporates and dries the earth, pavements, and ſurfaces of buildings, vaporizes and carries away ſo much water from the ſkin that it dries, cracks, and riſes in ſcales; that the body ſuffers a great waſte of ſubſtance; that on account of the neceſſity of reparation, the digeſtive powers increaſe rapidly in robuſt and healthy ſubjects; that the urine becomes thick and turbid; that the humours thicken and become viſcous, and diſpoſed to inflammation. Such is the ſource of catarrhs, defluxions from the lungs, pleuriſies, inflammatory

inflammatory fevers, proceeding, as we fee, from the fluggifhnefs, thicknefs, and vifcidity which the liquids have contracted, much more than from a fuppreffed perfpiration, as has hitherto been fo generally believed. From what has been faid, we may conclude, that in dry and windy cold weather, the perfpiration is the moft abundant poffible; that it fenfibly exceeds that of the fummer; and amongft the experiments that have been quoted, efpecially thofe of G. Rye, Robinfon, and Gorter, we find, when we read them with attention, refults favourable to the opinion which I have advanced.

14. We alfo fee, according to this theory, which is founded upon well demonftrated facts, and upon notions more precife than thofe which have hitherto been followed, that the contact of cold water covering the fkin muft prevent the perfpiration; that the bath cannot augment or maintain it, or even let any part of it fubfift, except in fo far as by its more or lefs elevated temperature, it augments the pulfations of the heart, and the force which impels the liquids toward the furface of the body; that frequently it would be either entirely checked or very much diminifhed in fubjects immerfed in a lukewarm or cold bath, or if the portion of their body which is out of the water, if the pulmonary furface did not perfpire in an increafing proportion; that their body would be very much augmented in weight, if a more abundant

abundant excretion of urine did not replace the water retained at the surface of the wet ſkin. We thus ſee why a covering of waxed ſilk applied over any part of the body becomes filled with water, and ſoon ſtops the perſpiration. We alſo underſtand the utility of ventilation, which diminiſhes the heat and the ſweat by renewing the ſolvent air around the body. We conceive that perſons wrapped up in blankets muſt have a moiſt ſkin, without on that account really tranſpiring, becauſe they want the contact of the air, the indiſpenſable agent of tranſpiration; and when phyſicians adviſe confinement to a warm bed, and the application of blankets, in order to make patients ſweat, the good which they thereby procure them is almoſt always the retention of the perſpiratory water which the air would have carried away from them, much rather than the diſcharge of a larger quantity of this liquid. There is even reaſon to think that this mode of treatment matures catarrhs only by actually retaining the water in the body, and thus favouring the dilution of the thickened portions of liquids, and their more eaſy ſeparation from the ſides of the canals to which they were in a manner attached by their glutinous and tenacious thickening. It is ſufficient to have announced the baſes of theſe new truths, in order to ſhow what productive applications they are ſuſceptible for the knowledge of the cauſes of ſeveral diſeaſes, and the inveſtigation of the means of combating

combating them, supported by direct experiments. They will become one of the bases of the new monument which chemistry must soon raise for the art of healing.

15. Physicians have long observed a remarkable analogy and striking relation between the urine and the perspiration; they have observed that the one of these evacuations frequently supplies the place of the other, and that they are constantly in an equilibrium which is always maintained when the body is healthy and vigorous. In fact, when the perspiration is diminished or suppressed, especially by the non-dissolvent or little dissolving state of the air, the urine is discharged in greater abundance, and it seems as if there were a direct passage open between the cutaneous pores and the tubes of the kidneys. Some anatomists even admit, on account of the rapidity and magnitude of this effect, another passage than that of the kidneys for conducting the humour of the perspiration into the bladder. Some moderns think that this function is performed by the system of absorbent or lymphatic vessels, without however having yet proved their immediate communication between the skin and the bladder. But this is not the point of view under which I ought here to consider the analysis of these two evacuations; the nature alone of the liquids which form them must especially form the object of my attention. I have already remarked, that some physiologists have found a real

real identity between the matter of perſpiration and that of the urine, and that the ſole difference which they have announced between them conſiſts in the greater quantity of water which the firſt conveys, and the leſs degree of ſaline acrimony which characterizes it. I muſt here add, that ſome of our recent experiments confirm this idea, and that Citizen Vauquelin and myſelf, after having diſcovered a particular urinary matter, which I ſhall deſcribe elſewhere by the name of *urée*, exiſting conſtantly in all the urines of the different animals which we we have been hitherto able to examine, have found it again in the reſiduum of the tranſpiration of the horſe after the evaporation of this humour. I ſhall alſo obſerve, that Citizen Berthollet has indicated a tranſpiration which is acid like the urine, and conſequently that chemiſtry has the means of determining this analogy which has been announced ſo long ago by the experience of phyſicians.

16. In deſcribing the different uſes of the tranſpiration, phyſiologiſts enumerate the ſoftening of the ſkin and of the epidermis, as alſo an excrementitious evacuation which carries out of the body matters, the abundance and acrimony of which might be equally prejudicial; they ſupport the latter opinion by the origin of numerous diſeaſes, which are generally attributed to diminiſhed, retained, repelled, or ſuppreſſed tranſpiration. Galen, after Aſclepiades, has ſtrongly inſiſted upon this uſe of

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tranſpiration, which we find was adopted in the ancient Grecian ſchools of medicine. Sanctorius has carried it ſo far as to pretend that as long as this function is in its regular ſtate, no diſeaſe is to be apprehended. Many phyſicians have believed that the diminution of the perſpiration in old perſons was the real cauſe of the gout, and the rheumatic affections ſo common at that age.

Some philoſophers, however, have called in queſtion this uſe of the tranſpiration; they have aſſerted that this evacuation might be diminiſhed, or even ſuppreſſed without injury to the individual: they have quoted the example of nations who cover their ſkins with greaſe and oil, and who, inſtead of ſuffering from this covering which intercepts the perſpiration, find in it the means of augmenting their ſtrength. Bacon even ſuggeſted that this artificial occluſion of the pores of the ſkin might be a means of preſerving life, and retarding the effects of old age. It is true that where they quote the pretended ſuppreſſion of the perſpiration during the winter, without the production of diſeaſe, the advocates for this opinion have committed a great error, as it appears, on the contrary, that in the caſe mentioned (No. 13), this evacuation is very conſiderable. There is reaſon to believe, that in the inſtances quoted by theſe authors, other excretions of the urine, of the pulmonary tranſpiration, and that of the internal cavities, increaſe in proportion

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as that of the ſkin diminiſhes, and ſupply its place.

17. Modern philoſophers have added ſeveral new notions concerning the uſes of the perſpiration, by repreſenting it as an abundant evaporation of water at the ſurface of the body: they have ſeen in it a means of abſorbing the too great quantity of caloric that diſengages itſelf from it, of regulating its temperature, and maintaining it at a conſtant term; of thus evacuating the exceſs of caloric which develops itſelf, either in the lungs by reſpiration, or in the circulation itſelf by the fixation of the oxigen which appears to be continued in it, and to follow its intimate combination. They therefore conſider this function in uninterrupted relation with the reſpiration, and as the regulator of the animal calefaction: they thus explain how, when this calefaction is augmented by any cauſe, the perſpiration, having ſuddenly become abundant, tends to moderate it, and to reſtore it to its original equilibrium. Perhaps the phenomena of the tranſpiratory function may be carried ſtill farther, and conſidered as the diſcharge of the water which is formed in the courſe of the arteries by a ſlow but continual combuſtion of the hidrogen of the blood by the oxigen abſorbed in reſpiration, as well as that which takes place in the pulmonary veſicles. This water carries away with it a part of the animal ſolids and fluids in the ſtate of vapour; and by thus evacuating the part

part of the organs that is too much anamalized and worn, it contributes as it were, to folicit their renovation. For the reft, thefe ideas deferve to be ftudied and fupported by experiments made with more accuracy, and under the guidance of more enlarged views than thofe which have given celebrity to the names of Sanctorius, Dodart, Keil, B. Robinfon, G. Rye, Linings, Gorter, &c.

18. There continually exudes in the internal cavities of the body, in all the hollow vifcera, in the dura mater, in the ventricles of the brain, the pleura, the mediaftinum, the pericardium, the peritoneum, &c. a humour which lubricates their furfaces, which the phyfiologifts have reprefented as a humid vapour, an internal *halitus*, a fort of internal tranfpiration, the exiftence of which has been proved by numerous obfervations. Haller has made exprefs mention of it in his great work on phyfiology. Borden confidered it as a ftream of vapour which ran through not only the internal membranous cavities, but alfo all the cells of the mufcular texture, and he reprefented the body to himfelf as confifting of cellular balls, all open and all communicating the one with the other, only contract from fpace to fpace. But thefe ideas, which were ingenious in their time, muft be modified by the knowledge of the lymphatic or abforbent fyftem, and the humour of which I here fpeak muft not be confounded with that which fills the abforbent veffels, and

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which always follows in them a determined course.

19. The humour of the interior cavities exudes from the extremities of the arteries, as is proved by injections, and nevertheless it differs from that which is exhaled by the skin; it is much less aqueous and charged with more fixed matters than the latter. We shall well comprehend the cause of this difference, when we consider that the perspiration is formed only of the substance which is capable of being volatilized and dissolved in the air, whereas the humour of the interior cavities is neither a vapour nor a gaseous solution, but a liquid which runs by the effect of the circulation and of the motion of the blood. In proportion as it thus exudes from the internal surface of the membranes which it moistens, it is re-absorbed by the orifices of the absorbent vessels, so that it never accumulates to such a degree as to distend these membranes; it always forms in them only a light mucous covering which separates from it and lubricates their surfaces, whilst the animal is in health and vigour.

20. We may distinguish the viscous, mucilaginous, gluey state of this liquid, by introducing the finger into these internal cavities and upon the membranous surfaces, either of living or of dead animals. We perceive, by the mere sense of touch, that this humour is really an albuminous and gelatinous solution analogous to serum. It is only by these simple experiments that we can estimate

estimate its nature; for it is not sufficiently abundant in the natural and healthy state to be capable of being collected and examined by chemical processes. Sometimes however it happens, that this lubricating serum accumulates in the visceral cavities; this takes place whenever the function of the system of absorbent vessels is languid, or when its energy is not sufficient for taking up again by suction the quantity of liquid which issues from the arterial extremities. Dropsy then exists, and the liquid which constitutes it, when extracted by the puncture, becomes sufficiently abundant to be subjected to analysis; so that we are then able to ascertain the nature of the internal humour.

21. Rouelle the younger was the first who examined what is called the *hydropic water*. That of the ascites, which he employed, afforded him all the characters of the serum of the blood. I have made the analysis of this liquid, extracted in different species of dropsies, of the breast, of the pericardium, of the ovarium, in the ascites, and I have constantly found in it the same characters. This liquid is generally viscous, gluey, yellowish, of a sweetish and somewhat saline taste, charged with flakes more or less abundant and voluminous, of a yellowish-grey colour. It is coagulated by fire, by the acids, by alcohol; it is precipitated by the calcareous and metallic salts; it turns the syrup of violets green: the flakes which swim in it are coagulated albumen; though

though generally fresh and unaltered in the hydropic cavities, it quickly putrefies by the contact of the air. When it is heated, it affords coagulated, porous, light masses, of a sulphur-yellow colour, and tremulous consistence; there remains a slightly yellowish liquid which does not coagulate. When diluted with water and heated, it forms a milky not coagulable liquid; it affords at its surface, by the progress of the action of the fire, a thick yellow pellicle like milk. Boiling water attacks and dissolves the matter that has been coagulated by the fire, so that it then presents the appearance of a gelatinous substance. However, we can obtain no real jelly from this liquor, though strongly evaporated and afterwards cooled; pellicles are separated from its surface from the beginning to the end and during the whole course of this evaporation. The albuminous matter therefore does not exist in it in the real state of gelatin.

22. Sulphur and phosphates are also exhibited by different processes in the hydropic liquor. The first is perceptible by the fetid smell which this liquor exhales when coagulated, by the colour which its vapour imparts to silver, by the sulphuric acid which is formed in it by the oxigenated muriatic acid, and which is discovered by the aid of the muriate of barites. As to the phosphates, lime-water, the solutions of barites and strontian, poured into the hydropic water, produce in it precipitates,

tates, which are eafily difcovered to be phofphates, on account of their infolubility and the manner in which they comport themfelves under the action of fire. The nitric folution of mercury forms in it alfo a flefh-coloured precipitate. The coat of the hydropic water, evaporated to drynefs and burned in a crucible, affords fome traces of calcareous phofphates, but lefs abundant than almoft all the coats of other animal matters. It is ufelefs to add, that the coagulum afforded by this water when heated, affords in diftillation the fame products as thofe of which I have fpoken in the hiftory of the ferum.

23. We muft not confound with the water of the internal furfaces of the membranes the ropy and mucous liquid which lines the fides of the hollow vifcera, of the canals communicating with the external part of the body, opening into the air, and immerfing themfelves into the interior part of the animal cavities, fuch as the oefophagus, the trachea, the inteftines, the urethra, the vagina, &c. The mucus deftined to lubricate thefe parts and to prevent their drynefs and rigidity, is of a different nature from the matter of the tranfpiration, though, like it, it iffues from the furface of the delicate and thin portion of the epidermis which invefts thofe canals, and which is called epithelium. Inftead of being evaporable like the tranfpiration, it contains a kind of gelatinous albumen, little fufceptible of deficcation, rather

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deliquefcent, which the air thickens only with difficulty, and which preferves the pliability, foftnefs, and mobility of the fides of the canals where it is depofited. It feems to be of a compofition entirely oppofite to that of the tranfpiratory humour, no lefs fufceptible of preferving its vifcofity, its foft and as it were unctuous confiftence, than the other is of becoming volatilized and diffolved in the air. Accordingly, it performs an entirely different office, fince it maintains the foftnefs and heat of the furfaces, whilft the other tends to dry and cool them.

Article VI.

Of the Synovia.

1. THE Synovia is an unctuous humour, deftined to lubricate the articular cavities, and to facilitate the motions of the heads of the bones upon each other. Clopthon-Havers was the firft anatomift who defcribed particular glands fituated in the articulations as the fource of this humour; but fome modern phyfiologifts now doubt whether fuch be the true origin of the Synovia. The following are the arguments which Xavier Bichat principally adduces, in a very good differtation upon the membrane,

membrane, which includes this liquor, publiſhed in the ſecond volume of the Memoirs of the Medical Society of Emulation at Paris. All the articulations do not contain the pretended ſynovial glands deſcribed by Clopthon-Havers. The mucous capſules of the tendons which facilitate the ſliding of theſe parts by the preſence of the ſame humour which their cavity contains, have not generally glands of this nature. Thoſe bodies, which were taken for glands by Clopthon-Havers, are only cellular texture ſuſtaining blood-veſſels collected into reddiſh balls; they are unfolded into floating membranes; they do not tumefy nor harden as the real glands do, and their pretended glandular nature diſappears under the ſcalpel or by other anatomical proceſſes: beſides theſe granulated lumps or cellular balls are found in other places beſides the ſynovial membranes.

2. The ſame anatomiſt does not confine himſelf to combating the opinion of Clopthon-Havers concerning the ſynovial glands and the ſource of the Synovia: he has collected a great number of facts and arguments in order to prove that this humour has another origin and to diſcover whence it proceeds. For this purpoſe he deſcribes with much greater accuracy and preciſion than had been done before him, the membrane into which the Synovia exhales, where it remains contained for ſome time, and is abſorbed ſo as to be perpetually renovated. According to his reſearches, this membrane,

membrane, which he calls *synovial*, and which is inclosed in all the articulations, is a bag, or kind of sac without orifice, folded together, of the nature of the serous membrane, analogous to the pleura, to the pericardium, thin, transparent, distinct from the articular capsule, and to the internal face of which it adheres, detaching itself from it below the heads of the bones, leaving a portion of those bare, passing over the articular cartilages which it covers, adhering strongly to them, folding back upon the inter-articular ligaments and cartilages and the glanduliform balls; so that the heads of the bones, the articular capsules, and the interior ligaments of the articulations are on the outside of this synovial membrane. We may extend and inflate it by blowing from the interior of the articulations at the points where the articular capsules are interrupted. It is this synovial membrane, contained, as we see, in the articulations, covering all the interior surfaces, filling their cavity, having a smooth, polished, and shining surface, upon which the sliding of the articulated bones takes place. Citizen Bichat thinks that it is formed by an intertexture of exhalant and absorbent vessels, the first conveying the synovia by exhalation, the second taking it up proportionally.

3. Founded upon this structure, this anatomist who has given an account of it, after having compared this membrane with those which he calls *serous*; that is to say, those

which occupy and inveſt the large cavities, cover the viſcera, and are ſacs without orifice, ſuch as the pleura, the pericardium, the peritoneum, the tunica vaginalis or of the teſticles, concludes from this analyſis that there conſtantly iſſues from the interior ſurface of this internal capſule of the articulations a gluey and viſcous liquid, as well as from thoſe of other ſerous membranes, and that this humour is what is here termed the *Synovia*. In order to confirm the identity of its nature with that of the lubricating humour of all the other cavities of the ſerous membranes, he follows its analogies under four general relations: 1. its nature is ſimilar; it is, like it, albuminous, ſince, like the latter, the Synovia, being of a viſcous conſiſtence, is coagulable by fire, by the acids, and by alcohol; which Clopthon Havers had already remarked; 2, it performs the ſame functions as the humour of the internal cavities, ſince, like this, it ſerves to render its ſurfaces ſmooth, and to favour the motion of theſe internal ſurfaces; 3, the Synovia preſents an equally ſtriking analogy with this humour in the diſeaſes to which it is ſubject; in fact, we obſerve its thickening give riſe to adheſions between the ſurfaces of the ſynovial capſules, as between the pleura, the peritonæum, and the viſcera which are contained in them; we alſo find hydropic accumulations of the Synovia, as we do of the humour of the other membranes; 4, finally, the ſynovial humour is abſorbed

absorbed by lymphatic vessels, and renovated by the continually renewed exsudation in the interior of the synovial membranes or capsules, like the humour of the other internal cavities.

4. However, Citizen Bichat finds a difference between the apparatus of the synovial capsules, as well as the formation of the Synovia, and the structure of the vessels of the ordinary serous membranes. He observes that the absorbent system of the synovial membranes must differ from that of the other absorbents situated in the other parts of the body, since in the leucophlegmatia the sub-cutaneous absorbents are every where obstructed, whereas this obstruction does not take place in the articulations. This observation, however, is not sufficient for establishing a difference between the two systems, and may be explained by the diversity of the layers of the absorbents; for it is known that the superficial or sub-cutaneous absorbents form a system, if not totally independant of the deep-seated lymphatics, at least sufficiently separated from these not to participate always in the same affections with them. I am much more struck with a difference of infinitely more importance between the Synovia and the humour of the internal cavities; namely, that of the quantity and of the physical properties which very eminently distinguish these two liquids from each other. The latter is never sufficiently abundant to run out at the orifice of the membranes, nor thick and stringy,

as

as we find the Synovia: accordingly, when this thickens, it gives riſe to anchyloſes or ſolid adheſions of the joints, whereas the humour of the membranous cavities forms only mucous, tenacious and flaxey ligaments.

5. I have already obſerved that the Synovia is an unctuous liquid: its viſcoſity is ſuch, that it was formerly compared to an oil, and almoſt to thoſe greaſy matters which are employed for facilitating the motions of wheel-work. This ſingle character, which all anatomiſts have aſcribed to the Synovia, would be ſufficient to diſtinguiſh it from the humour of the interior cavities, though the expreſſion which has been employed for rendering it is altogether improper. It is in ſufficient quantity to be collected with eaſe at the orifice of the ſynovial capſules which contain it in the articulations of large animals; it is either tranſparent or ſlightly opaque, a little greeniſh, of a conſiſtence analogous to that of white of egg, of a ſweetiſh and ſomewhat ſaline taſte, of a faint animal ſmell, analogous to that of frog's ſpawn. Its ſpecific gravity is ſuperior to that of diſtilled water. Phyſiologiſts have hitherto given only a very imperfect and very general notion of this liquor. None of them have made a real chymical analyſis of it. Citizen Marguerron, apothecary to the Maiſon des Invalides in Paris, read to the Academy of Sciences, in June, 1792, a chemical examination of the Synovia, and this is the only inquiry made with any attention that I know. In exhibiting the

the refults of his experiments, I fhall fubjoin fome reflections concerning the neceffity of repeating them and reviewing fome facts which deferve all the attention of the philofopher.

6. Citizen Margueron eafily procured the Synovia of the bullock from a butcher's fhop where feveral were killed every day. This liquor affumes a gelatinous confiftence fome time after having been extracted from the joints, both in the cold and in a mild heat, as well in clofe as in open veffels : it does not long retain this confiftence ; it even foon lofes its firft natural vifcofity, and depofits a ftringy matter ; it prefents fome differences in its analyfis, according thefe different ftates ; when it is filtrated as foon as it has been extracted from the joints, it neverthelefs preferves all its properties. A thin layer of fynovia expofed to a dry air in a flat veffel, dries into a fcaly net-work, in which two faline matters are obferved ; the one in cubes, which is muriate of foda ; the other efflorefcence and eafily diftinguifhable as carbonate of foda ; the frefh fynovia alfo turns the fyrup of violets green. In a moift air this liquor becomes altered and putrefied ; whilft it lofes its vifcofity, it becomes turbid, exhales a fmell of putrid fifh, affumes a red or brown colour, becomes covered with a pellicle, and leaves a foft and fetid refiduum, from which lime and the alkalis difengage a large quantity of ammonia. Diftilled in the retort, the Synovia afforded Citizen Margueron a very alterable water charged with ammonia ;

ammonia; at laſt, an empyreumatic oil, carbonate of ammonia, and a coal which contained muriate of ſoda, and phoſphate of lime.

7. The Synovia eaſily mixes with cold water, in which it firſt occupies the bottom, but diſſolves in it by agitation. The author obſerves that it gives to water a very remarkable viſcous fluidity, as it is very ſenſible even when we take ſix parts of water to one of this humour. The mixture froths much by agitation: frequently in ebullition, it preſerves its viſcidity, becomes opaque, milky, and exhibits ſome pellicles at the ſides of the veſſel. The author was ſo ſtruck with the conſiſtence communicated to water by the ſynovia, that he aſſerted no animal liquor preſented any thing ſimilar; he thought he had found its cauſe by the action of the acetous acid. The addition of this acid to the mixture of ſynovia and water cauſed it to loſe its viſcoſity, rendered it clear and tranſparent, made it depoſit a maſs of white fibres eaſy to be ſeparated from the liquor, by tubes of glaſs, which carried them away in a ſingle piece. The liquor thus clarified being put to evaporate, afforded him albuminous pellicles and afterwards cryſtals of muriate of ſoda, and of acetite of ſoda in ſtriated priſms. It was undoubtedly from this experiment that Citizen Margueron ſuppoſed albumen to exiſt in the ſynovia in two ſtates, more denſe than in the other animal liquids, and conſequently capable of imparting a greater viſcidity

to water. I ſhall ſoon ſhow that there is reaſon to believe that this property may depend upon another cauſe which could not even have been ſuſpected in 1792, or at leaſt that it deſerves to be ſtudied under new relations, and with a new intereſt, as it may greatly elucidate both the functions of the ſynovia and the nature of its morbid affections.

8 Citizen Margueron treated the ſynovia with different acids. The concentrated ſulphuric acid, he ſays, produced a flaky precipitate, eaſily ſoluble in the liquor, and which did not deſtroy its viſcidity: the ſame circumſtance is obſerved, with the ſulphureous, nitric, muriatic and acetic acids. Diluted with from 12 to 15 times their weight of water, theſe acids impair the tranſparency of the ſynovia without deſtroying its viſcous conſiſtence; nevertheleſs, when weakened to ſuch a degree as to leave their acidity ſcarcely perſceptible, they cauſe the viſcoſity of this liquor to diſappear, render it clear and tranſparent, and ſeparate from it a ropy matter which may eaſily be obtained inſulated. The acetous acid eſpecially preſented this character, and he employed it for determining in this manner the proportion of the conſtituent principles of the ſynovia. 288 parts of this liquor extracted from the bullock gave him alſo 34 parts of ſtringy ſubſtance, afterwards 13 parts of albumen in pellicles obtained by evaporation, then 5 parts of muriate of ſoda

and 3 of acetite of ſoda; whence he concluded that it conained 233 parts of water.

9. But what moſt deſerves to engage our attention in this chemical inquiry is undoubtedly the nature of the ſtringy matter ſeparated from ſynovia by the addition of the weak acids, upon which Citizen Margueron has made ſome particular experiments. He has juſtly conſidered it as a particular circumſtance which does not preſent itſelf in any other animal liquor, and which conſequently deſerved to be ſtudied with ſome attention. Preſuming, from the properties which this ſubſtance preſented to him, that it could not be real albumen, though he afterwards deſignated in it the reſult of his analyſis as *albumen in a particular ſtate*, he wiſhed to aſcertain whether it might not be compared with the glutinous matter of wheat. He examined it under this new point of view, and he aſſures us that he did not remark any ſenſible difference of colour, taſte, or odour between theſe two fluids; their elaſticity and their adheſion to the fingers were the ſame; boiling water gave the ſame conſiſtence to both; the concentrated acids and alkalis diſſolved both equally. However he has obſerved differences between them; the ropy matter of the ſynovia diſſolves by agitation in cold water; this ſolution froths by agitation; the acids and alcohol precipitate it in flakes; caloric produces in it a very white and very rarefied ſcum. Theſe differences appeared to him ſufficiently conſiderable to induce him to

conclude from his examination that the ſtringy matter of the ſynovia was albumen in a particular ſtate. We here find a too manifeſt contradiction between the different aſſertions of the author: as he had ſaid ſome lines higher up that if it had been albumen, *the ſame means employed in order to obtain it from any other animal matter* would have preſented it *in a very different ſtate;* not to perceive the uncertainty and embarraſſment in which he found himſelf involved by the properties of this ſingular ſubſtance. Hence, I ſuſpect that this matter may really be very different from albumen, and that it deſerves to be examined anew with the greateſt attention.

10. The ſynovia affords very perceptible precipitates with lime water, as well as with the alkaline ſolutions of barites, of pot-aſh, of ſtrontian, and even with ammonia. The oxalic acid likewiſe produces in it a very ſenſible precipitation: all theſe effects manifeſtly proceed from the phoſphate of lime which it contains. Citizen Margueron found very ſenſible traces of ſalt in its coal; but he has neither determined its proportions nor diſcovered the mode of its ſolution in this liquor, in which however there is reaſon to believe that it is capable of performing an important function. The carbonates of pot-aſh and of ſoda unite very well with the ſynovia, without producing any change in its viſcidity; the cauſtic alkalis in ſufficient quantity render it more fluid, and even diſſolve

the synovia that has been dried by the contact of the air. This last mentioned character of the solubility of the synovia, when thickened by spontaneous evaporation in alkaline liquors, seems to announce in an incontrovertible manner the albuminous nature of this humour: however, we might draw this immediate conclusion; for, besides the uncertainty in which the author of this analysis has been involved by his experiments upon the fibrous part of the synovia precipitated by the weak acids, it is very evident that matters extraneous to albumen are soluble in the caustic alkalis. Besides, the very facility or the complete state of this solution that has been well remarked by Citizen Margueron, does not belong, at least in this degree of energy, to albumen, and seem to indicate another matter, especially an acid; and we shall see in one of the subsequent articles that there are some reasons to suspect the presence of the uric acid in this particular liquor.

11. Alcohol precipitates the synovia without causing its viscidity to disappear. It separates from it white flakes, insoluble in the liquid, the nature of which Citizen Margueron has not indicated. The albuminous part of the synovia is certainly separated by this re-agent, but must be allowed to believe that some other substance is at the same time precipitated, according to what the author of this inquiry has remarked. On adding acetous acid to the

mixture

mixture of ſynovia and alcohol the viſcidity of this mixture diſappears; there is ſeparated, he ſays, a matter ſimilar to that which he obtained from this liquor treated by the weak acids, and reſpecting the albuminous nature of which there is room for ſome objection, according to what I have already advanced. If this liquor contained uric acid or any of its ſaline combinations, the one or the other would certainly be ſeparated with a portion of albumen; the firſt as being little ſoluble in water or not at all ſoluble in alcohol, the ſecond as being coagulable by this re-agent. It is therefore well proved by this conſideration, as well as by all thoſe which I have detailed in the preceding numbers, that the analyſis of the ſynovia ſtill demands farther reſearches, and promiſes uſeful diſcoveries to ſuch chemiſts as may think fit to occupy themſelves with it.

12. Citizen Margueron had concluded from his analyſis that 288 parts of ſynovia which he had examined as far as to the proportion of its conſtituent materials, contained 34 parts of albumen *in a particular ſtate*, 13 parts of ordinary albumen, 5 parts of muriate of ſoda, 2 parts of carbonate of ſoda, from 1 to 2 parts of phoſphate of lime, and 232 parts, or more than three-fourths of its weight of water. I have explained the reaſons which induce me to think that this liquid contains, inſtead of the firſt of theſe materials, ſome particular animal ſubſtance, of a nature not yet ſuſpected, which

muſt have a more or leſs conſiderable relation with the diſeaſes which affect this liquor, eſpecially the Anchyloſis, the articular concretions, arthritic tophous humours, &c. Should this latter ſuppoſition be confirmed by new experiments, it will explain the differences which are already known between the humour of the internal membranes or of the interior membranous cavities, and that of the ſynovial capſules; it will prove that notwithſtanding the analogy of ſtructure which exiſts, and which I readily admit, with Citizen Xavier Bichat, between the ſynovial membranes and the other ſerous membranes, nature has intended, with the ſame organic apparatus, to give riſe to different products, and that we are not to infer, notwithſtanding the anatomical reſemblances, that the liquids ſeparated by analogous ſyſtems of organs muſt alſo reſemble each other, till after ſo accurate and ſo careful a chemical analyſis has been made, as to leave no room for doubt or uncertainty.

ARTICLE

ARTICLE VII

Of the cellular, membranous, tendinous, aponeurotic, ligamentous, glandular Textures, and of the Gelatin or the Glue which these Textures yield.

1. I COMPREHEND under a single article six organic-animal matters different from each other in their texture, their form, their appearances and their structure, because they are of the same chemical composition, and afford the same products in their analysis. All these different textures are generally diffused in the bodies of man and of the other animals. There is not one of their different regions which does not present a greater or less quantity of them to the scalpel of the anatomist; so that they may be ranked in the class of parts that contribute the most universally to the organization. Each of them has both particular anatomical characters and particular uses that distinguish it. The knowledge that has hitherto been acquired concerning their intimate nature and composition is undoubtly not so much advanced as that of their anatomical structure; it is however sufficient to approximate them to one another and to oppose them collectively in their chemical properties compared together to the other animal

animal matters. Let us caſt a haſty glance upon their ſtructure and characteriſtic differences, and afterwards ſee what they preſent in common with each other, in the phenomena which belong to their decompoſition and to the intimate nature of their conſtituent principles.

2. The cellular texture, which is alſo called *mucous, cribrous texture,* conſiſts of lamellæ, of thin, tranſparent, mucous or gelatiniform plates, of a delicacy which exceeds that of the fineſt gauze, and which may be compared with the light texture whieh dilated into a ſpherical form by a current of air blown into a ſolution of ſoap. Theſe laminæ are found between the interſticies of all the fibres; they are perceived when we ſeparate them; they connect them together, and at the ſame time ſeparate them from each other; they cannot be well ſeen except at the moment of this ſeparation; finally, they reſemble a gluey form extended upon the parts where they are obſerved. This texture, called the cellular, *tela celluloſa,* becauſe it was believed to conſiſt of cells opening into each other, forming a continued ſeries throughout the whole body, is in fact found in all its parts. It is ſituated under the ſkin in layers, more or leſs dilated by the fat, on the outſide of the muſcles and between their fibres, in the intervals which ſeparate them from the contiguous muſcles, along the blood-veſſels, around and even within all the viſcera. They are not ſmall balls or veſicles communicating freely with each other, formed

formed of ſoft and tranſparent membranes, as Bordeu thought, but reticulations of knotted and lymphatic veſſels, ſupported upon membranous laminæ, and containing a liquid moving in theſe ducts.

3. I here denominate membranous texture in general thoſe white, thin, tanſparent or opaque parts, extended into layers or kinds of tables, frequently folded together, rolled into cylindrical forms, applied in large laminæ, incloſing or covering the viſcera, forming ſometimes wholly or in part entire organs, exiſting throughout the whole body, and deſtined either to contain or to ſeparate and inſulate the different parts of the body, having only a white or dull grey aſpect, without brilliancy, without ſilvery ſurface, and never forming ſolid cords. Such are eſpecially the dura mater, the pia mater and the arachnoid tunic in the cranium, the pleura and pericardium in the thorax, the peritonæum in the abdomen, the ſides of the veſſels, eſpecially of the abſorbents; the perioſteum about the bones, the medullary membrane in their interior, the articular and mucous capſules, the vaginal and albuminous tunics and a multitude of other analogous parts. We might even claſs under the ſame head the epidermis and the ſkin, if theſe organs did not preſent certain properties which render it neceſſary for us to conſider them in particular.

Citizen Xavier Bichat has publiſhed, in the ſecond volume of the Medical Society of Emulation,

Emulation, of Paris, a very good diſſertation upon the membranes and their general relations of organization. After having remarked that the anatomiſts have not ſufficiently generalized the ſtructure of theſe important parts, nor diſtinguiſhed their varied texture, he divides all the membranes of the human body into three claſſes: the *mucous*, the *ſerous*, and the *fibrous* membranes.

The firſt line the interior of the hollow organs which open upon the external ſurface of the body; folded or doubled into their internal ſurface, they are lubricated with a mucous juice; they are continuous with the ſkin: covered with an epidermis which detaches itſelf in ſhreds in ſome diſeaſes, their principal texture is formed of a ſpongy tunic which reſolves itſelf into cellular texture by diſſection, maceration, &c.; they are endowed with ſenſibility, and maintain the relations of the interior part of the body with extraneous ſubſtances, as the ſkin does of the exterior; they evacuate by their ſurface a mucous liquid, conſtitute a grand emunctory, have diſeaſes peculiar to themſelves, ſuch as catarrh and polypus, exhale the animal mucus by friction, irritation, and envelop the bodies which remain in them: ſuch are the interior of the inteſtines, of the vagina, &c.

The *ſerous* membranes occupy the large cavities, inveſt them, cover the viſcera placed on the outſide of them or in their folds, are facs

without

without orifices, ſmooth at their internal ſurface and unequal at their external; they are lubricated in their cavity by a ſerum that is diſcharged by exhalation, and ſucked up again by the abſorbents; whereas the thick mucous of the firſt is always like an excretion, after it has been ſeparated by cryptous or mucous glands. They have their particular diſeaſes, eſpecially dropſy, adheſions, peculiar inflammations. They are laminæ or large ſacs which inſulate the viſcera, which may be conſidered as grand reſervoirs in which the lymph is elaborated, which favour the motion of the viſcera. In this order are to be ranked the pleura, the pericardium, the peritonæum, &c.

The *fibrous* membranes, which are leſs numerous than the two preceding, are hard, of a fibrous and white texture, perforated in order to ſuffer the veſſels to paſs through, &c. without folds, thicker than the ſerous, and leſs thick than the mucous membranes, without any liquid that moiſtens them, adhering in all their points, endowed with a particular ſenſibility and tenſion, elaſtic, frequently entering into the organs in which they form a fibrous ſkeleton, and the texture of which they ſupport. It is in this manner that the perioſteum inveſts the bones, the tunica albaginea, the teſticles, &c.

4. The tendinous texture is eaſy to be diſtinguiſhed; brilliant and ſilvery, ſmooth and poliſhed, conſiſtent and tenacious, ſtrongly reſiſting preſſure and extenſion, ſupporting a very

heavy

heavy weight before it breaks, formed into a denſe and ſolid cord, rounded or little angular, difficult to be cut, terminating the fleſhy fibres, and ſerving to fix their attachments to the bones, &c. The tendon is the cord, immoveable of itſelf, which, when drawn by the contracted muſcles, cauſes the bones to move one upon the other. It is in ſome reſpect merely a paſſive agent. It is very difficult to cut it acroſs or perpendicularly with the direction of its fibres; it is eaſily ſeparated into faſcia in the direction of their length. It almoſt always ſuppoſes the exiſtence of the muſcles, of which it is a kind of appendage.

5. The aponeuretic texture is a variety of form in the tendon: inſtead of being a hard and ſolid cord, the aponeuroſis is a kind of membrane which covers the fleſhy fibres; which frequently invelops the exterior of the muſcles, to the fibres of which it ſerves as a point of attachment, as a covering which limits their dilatation, as a link which retains their faſcia and their fibres adherent to each other. It is diſtinguiſhed by its fibrous, ſmooth, poliſhed, ſilvery, brilliant ſurface, which ſometimes imitates the luſtre of ſilver. It is an intertexture of flat, hard, cloſe fibres, which have ſeveral different directions, beſides that of the fleſhy fibres which they follow in one of their directions.

6. The ligament, as a particular texture, being ſituated almoſt always between the bones which

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it ties together more or leſs ſtrongly, from which function it has derived its name, is found in the vicinity of the articulations, and exiſts in them all without diſtinction, conſequently throughout the whole continuity of the body. It is a compound of grey, ſolid fibres, very conſiſtent, very tenacious, very reſiſting, capable of being pretty conſiderably elongated and drawn without breaking, eaſily accommodating themſelves to all the motions which the articulations admit, permitting a certain ſeparation between the bones which form them, oppoſing their reciprocal diſplacement or luxations; ariſing between the laminæ of the oſſeous texture itſelf by filaments which are implanted there, connecting in the ſame manner ſome cartilages to the bones, or to each other.

7. Finally, I deſignate, by the name of glandular texture, the fibrous parenchyma interpoſed between the bundles of lymphatic veſſels, the intertexture of which conſtitutes the ſtructure of the conglobate glands. This has hitherto been ſaid to be cellular texture, but we need only diſſect theſe glands with ſome attention, and cut them in different directions, in order to be convinced that this notion is inaccurate. It muſt be remarked that I do not confound with the texture of the conglobate or lymphatic glands, which are found throughout the body, the parenchyma of ſome large conglomerate glands or glandular viſcera, ſuch as the liver, the ſpleen, the kidneys, &c.

Each of thefe vifcera has an intimate nature different the one from the other, as they are of a ftructure peculiar to themfelves.

8. Thefe ten organic textures, without being perfectly of the fame nature, prefent however, in moft of the trials and experiments to which they are fubjected, refults fufficiently fimilar and related with each other, to authorize us to place them together, and to fuppofe in them an analogous general compofition. All of them are infoluble in cold water; and when we leave them to foak or macerate in it for fome time, they become fwelled, dilated, undergo a feparation between their fibres and their laminæ, become foft, mucous, eafy to be torn, incoherent in proportion as they are altered. Moft of them, fermenting with greater or lefs rapidity, when they are moiftened or immerfed in water at a temperature that exceeds 12 degrees of the thermometer, pafs into an acid ftate more or lefs pungent and fenfible to the fmell; fo that we are tempted to confider them as a kind of vinegar. All of them, after the firft period of their fpontaneous decompofition, putrefy rapidly, and produce ammonia, which however is difengaged from them in lefs abundance, and with a lefs fetid odour than is the cafe in other animal fubftances.

9. The fame membranous and white animal matters, when expofed to a conftant mild fire, or to the contact of air at a degree of temperature exceeding 18 or 20 degrees become brittle

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and tranſparent by drying: they are then unalterable. When they have thus become brittle, and have loſt all their tenacity, however, no other intimate change has taken place in them, except the volatilization of the water which their fibres contained, either ready formed, or compoſed at the very moment of the drying action of the caloric. A ſtronger heat briſkly applied to theſe dried organs cauſes them to ſhrink, to move, to contract in all directions, as we ſee in a violin-ſtring thrown upon burning coals; afterwards they melt, ſwell, inflame with difficulty, diffuſe an odour of little fetidity, and leave a pretty light coal eaſy to be incinerated. When we heat them in the retort, we obtain from them the ordinary products of animal matters, but leſs oil, leſs carbonate of ammonia, leſs fetid gas; in general, they appear the leaſt animalized of the animal compounds.

10. The moſt marked character, or the moſt characteriſtic property which theſe white textures preſent, is that of ſoftening quickly and diſſolving entirely in boiling water, and of forming, when this ſolution is ſufficiently charged, a liquid, viſcous and gluey fluid whilſt it is hot, which concretes into a tranſparent and tremulous jelly by cooling. It is in this manner, and with three or four of theſe textures at a time, that the Flemiſh or Engliſh ſtrong glues, as they are called, are prepared in various manufactories: the Flemiſh, after having cauſed theſe bodies to diſappear entirely, or al-

moſt

most entirely, by keeping them for a sufficient length of time in boiling water, strain it off clear, and evaporate it to such a degree, that, by cooling, it acquires a perfectly solid consistence. The alimentary jellies, which are also prepared in the kitchens, the tenderest and most savory parts of these white textures being chosen for the purpose, are of the same nature, and differ from the glues only in the choice of the substance of which they are formed, and by the liquor being less thickened and concentrated.

11. We here recognize the same substance as that which has been found in the serum of the blood, coagulated by fire, and which distinguishes itself in it from the albuminous part with which it is mixed, by a semi-transparency, a soft and tremulous consistence, and solubility in water: this is the gelatin. The properties presented, when extracted by water, and in the state of jelly, by this substance, which forms, as we have just seen, the base of the white fibrous or membranous textures, or organs, distinguish it in an eminent manner from albumen, from fibrin, and from every animal matter; its taste is weak and faint; it feels mucous and gluey between the fingers, the temperature of which softens it; it melts in the fire, and even becomes liquid at 36 degrees of temperature; it no longer preserves its original viscidity, does not adhere to the vessels, but runs like water; when it has been left to

cool,

cool, it concretes into jelly, as before its fusion, which has not altered it.

12. The gelatin extracted from the white organs, or textures, heated gently and slowly in the liquid form which the first impression of the fire has given it, thickens, becomes coloured, viscid, of the consistence of honey, and at last assumes a concrete, solid, and transparent form, similar to horn. It is then glue, which is hard, elastic, of an orange-yellow, or red colour, brittle, soluble in boiling water, and which, in general, acquires the more solidity, colour, and glutinous tenacity by its solution, as it has been extracted from older or more robust animals. When we subject it to decomposition by the fire in a retort, we obtain from it an ammoniacal water, a fetid oil of little thickness, zoonate of ammonia and ammoniacal carbonate; it affords little gaseous product. The coal which it leaves is light, voluminous, and porous; easy to be burned, affording neither soluble phosphoric salt nor metals, but only phosphate of lime and muriates of soda and pot-ash. The gelatin becomes sensibly acid before it passes into putrefaction, and affords ammonia.

13. Cold water dissolves it, by being continually agitated with it for some time; hot water immediately melts it, when its temperature exceeds 25 degrees; and this is the reason why jellies cannot be made to assume the proper consistence in the summer without the ut-

most difficulty. When the gelatin has been dissolved in a large quantity of water, it can no longer become fixed into a jelly by cooling, and it is necessary that this too dilute solution should be evaporated, in order to restore to it this property; it is always made to lose this property of assuming the gelatinous form by refrigeration, in proportion as we multiply the action of the caloric, or expose it too many times to the fire. The acids, even the weakest, dissolve the gelatinous matter very easily and speedily. The alkalis, likewise, possess this property, but in a less marked degree than the acids. The nitric acid disengages but very little azotic gas from the gelatin, and changes only a very small portion into fat, but the greater part into oxalic acid; the solutions of barites, of lime, and of strontian, poured into a solution of gelatin, produce in it a precipitate of phosphate of lime.

14. Several of the properties that have hitherto been described in the gelatin, and especially its form, its transparency in the state of jelly, its acescence; the small quantity of ammonia, of oil, and of fetid gases, which it affords by the action of fire; the small quantity of azotic gas, and oily substance which is extracted from it by the nitric acid, which converts a great part of it into oxalic acid; its rare and swelled coal, are in favour of the opinion of those who considered this matter as having much analogy with the vegetable mucilages, and who be-

lieved

lieved it to proceed from the mucous vegetable ſubſtance, that had paſſed almoſt unchanged into the body of the animal. This, however, is a hypotheſis which will appear little probable to thoſe who conſider that the nature of every aliment is changed, from its reception into the ſtomach till its lamellous or fibrous application to the different organic textures which it is deſtined to nouriſh; and beſides, notwithſtanding this analogy between the gelatin and vegetable mucilage, properly ſo called, there exiſts a real difference which ſhows itſelf in the putrefaction, of which the firſt is ſuſceptible, but not the other.

15. A ſtill greater difference is conſtituted by the manner in which tannin acts upon gelatin, whereas it produces no effect upon the vegetable gummy mucilage: when we pour into a ſolution of animal jelly or glue, water charged with tannin, it produces a precipitate of a fawn-yellow colour, thick, in very fine flakes, which ſuddenly approach each other, and ſoon form a ropy, glutinous, elaſtic maſs, extenſible by agitation, kneading in the moiſt hands, like the gluten of the flower of wheat. This compound of tanned gelatin is dried by the contact of the air, becomes hard, brittle, of a ſmooth texture, brilliant, vitreous, and reſinous in its fracture; it is inſoluble in water, unalterable in the air; it reſiſts many agents and re-agents; it is incorruptible, analogous to ſkins that have been too much tanned, and

when it is rubbed it exhales a ſtrong tanny odour; it may be conſidered as a paſte, ſuſceptible of being employed for different uſes, and of which the induſtrious arts might avail themſelves with great advantage, if they ſhould occupy themſelves with it.

16. Finally, the animal gelatinous matter comports itſelf alſo in a very particular manner with alcohol, which does not diſſolve it when it is in the form of jelly extracted by water, but even ſeparates it from this liquid when its ſolution is concentrated, which condenſes its fibres or laminæ, when they belong even to the organs, the texture of which they in a great meaſure conſtitute: ſo that theſe organs, immerſed in alcohol, are preſerved and condenſed in it, without loſing any thing of their form and ſtructure, except a ſmall portion of their diameter. This is exemplified in the membranous organs dreſſed, diſſected, and prepared anatomically, and afterwards ſuſpended by threads in bottles filled with alcohol: however, this method of preſerving them in the anatomical collections has only a certain period of duration, and at laſt ſuffers an intimate change to take place in their texture, which ſeparates from it laminæ, foliations and fibres, the precipitation of which we obſerve at the bottom of the veſſels in which they are contained.

17. Though I conſider the ſix white organic textures as belonging to a ſingle matter, to a ſingle gelatinous chemical compound, the diſtinguiſhing

tinguifhing character of which is to be infoluble in cold, but foluble in boiling water, fo as to give rife to what is called an animal jelly; this notion is, however, not to be underftood in too rigorous a fenfe; neither ought we to confider thefe fix textures as intirely and perfectly homogeneous. The mere difference of their refpective form, afpect, colour, ftructure, denfity, and tenacity, would fufficiently contradict this pretended identity. Though the chemical anlayfes, which have not yet been fufficiently multiplied, have not yet led to a fufficiently accurate determination of the circumftances in which the mode of their diverfity, fo apparent to the anatomift and phyfiologift, confifts; however little advanced this analyfis may as yet be, we may neverthelefs find in their comparifon and in their refult, efpecially when we call to our affiftance thofe prefented by the arts that are exercifed upon thefe fubftances, a feries of facts fufficiently interefting to eftablifh fome ufeful diftinctions between thefe different textures, and to fatisfy the anatomift, who cannot, from his diffections, be perfuaded of this pretended identity of organs, which to him are really very different. It therefore remains for me to remark the varied modifications of chemical nature between the fix kinds of textures, which I have hitherto prefented only as being of a fimilar gelatinous nature.

18. The

18. The very light and froth-like lamellæ of the cellular, or mucous texture, prefent the gelatinous matter in the pureft, the moft infulated and the moft marked ftate; of this we may convince ourfelves, by the mere confideration of what happens to them by their action in boiling water. Thefe lamellæ diffolve and melt fo completely, that they difappear in the water of thefe decoctions, and all the fibres which they connected together are afterwards found feparated, incoherent, naked, deftitute of the integument which enveloped them on all fides, and the water thus performs a kind of diffection, which is frequently of ufe to the anatomift in his diffections. It is the folution of this texture accompanying the flefh which gives to certain broths the property of concreting into a jelly.

19. The textures of thin white tranfparent membranes, fuch as the pia mater, the arachnoid tunic, the epiploon; thofe of ftronger membranes, as the fubftance of the peritonæum, of the pleura, of the pericardium, part of the tunics of the ftomach and of the inteftines, the perioftеum, differ a little from the cellular lamellæ properly fo called; though anatomifts have believed them to be formed of thefe lamellæ united and condenfed, from the circumftance that water does not attack them, except with much greater difficulty and with the aid of a longer fpace of time. In order to

diffolve

diffolve them it is neceffary to let them macerate for feveral days in warm water, to feparate the lamellæ and fill their interftices with the aqueous liquid, and afterwards to boil them for a long time in a large quantity of water, and keep them immerfed in it, agitating them inceffantly. We fhould affirm that the gelatin is not fo pure in it, that it is inveloped, as it were, in an infoluble and tenacious fubftance which prevents its fufion. The manufacturers of glue are well aware of this difficulty; the animal matter is fufficiently denfe, fufficiently compact in thefe organs, to dry in the air when thefe membraneous parts are thin and extended, as is exemplified in the art of making cat-gut ftrings. We may alfo combine flowly, particle by particle, the fubftance of this texture with tannin; and at fome future time advantage will be derived from this kind of tanning of membranes or inteftines, by keeping them for fome hours immerfed in a folution of tan, in order to communicate to them a greater folidity and an ufeful inalterability, at the fame time preferving their tenacity and elafticity. For the reft, Chemical analyfis has not exactly determined in what this difference between the membraneous texture properly fo called and the cellular texture confifts; but it is now in progrefs towards determining it.

20. The tendons and the aponeurofes, which are flat tendons, though confifting of folid cords or very tenacious layers, approach more

to the cellular texture properly ſo called. It is remarked in the boiled meat which is ſerved up at our tables: all its tendinous and aponeurotic parts are melted or ſoftened, when they are well boiled, into a ſort of yellowiſh, tranſparent, gelatinous glue, which ſome perſons prefer, and which in fact has a ſufficiently agreeable taſte. In the preparation of glues, all the tendons are melted and diſappear intirely in the water; they even form the major part of the gluey ſubſtance, and give to water that conſiſtence and viſcidity, from whence jelly is produced by cooling. When the tendons, being drawn out and extended in order to make them preſent a larger ſurface to the air, are dried, they become tranſparent and ſolid, and at the ſame time acquire a yellow or reddiſh colour, as we ſee in dry anatomical preparations.

21. The ligamentous texture, though it alſo contains gelatin which is extracted from it by boiling water, is nevertheleſs of all the white organs that which partakes the leaſt of the gelatinous nature. The familiar and domeſtic fact of the meat boiled in our aliments proves this in a direct manner. At the ſide of a tendon that has been ſoftened and melted into jelly we frequently ſee upon our tables a cord, generally flat and thick, of a white opaque matter, hardly at all ſoftened, and of ſuch tenacity and hardneſs that it is impoſſible for the teeth to attack it, and which cannot be eaten, on account of its exceſſive reſiſtance to maſtica-

maſtication. This very remarkable want of ſolution, at the ſide of membranes of the ſame fleſh, ſoftened and diſſolved in the ſame water and in the ſame of time, announces not only that the ligamentous texture is much more denſe than that of the other white parts, but that it is probably of another nature; reſpecting which chemiſtry has not yet decided. The ſame is the caſe with the membranous coats of the arteries and veins. Beſides the fleſhy fibrils and the cellular layers which form a part of them, there is in their texture a matter analogous to the ligament, which reſiſts the action of boiling water, and is not converted into gelatin like the preceding textures: it is poſſible that this matter might be formed by the fibrin; but we have no fact that proves it with the accuracy requiſite to authorize us to admit the reſult. This texture of the blood-veſſels is extremely different from that of the lymphatic veſſels: the latter though ſufficiently hard and reſiſting in proportion to its extreme tenuity, neverthelefs melts pretty quickly in water and forms jelly, as we ſee in the laminæ of the cellular texture, which modern anatomiſts have diſcovered to be a tiſſue of abſorbent veſſels.

22. I muſt obſerve the ſame of the texture of the conglobate glands, deſignated by anatomiſts as bundles of lymphatic veſſels folded together and united with each other by cellular texture. Were this its real nature and ſtructure, this texture would ſoften and melt intirely in water, to which

which it would impart the gelatinous character. However, instead of dissolving in this manner, though they do yield a little jelly, the conglobate glands harden and resist the action of a large quantity of boiling water. This resistance is still more considerable in the texture of such of these glands as have acquired a more or less considerable enlargement, and a greater or less degree of induration, in the chronic affections that have been designated in so improper, or at least in so vague a manner, by the name of obstructions, as we find them in persons afflicted with scrophula, &c.

23. Finally, the texture of the skin, which has always been compared with that of the preceding white, soft, and membranous organs in general, and which in fact presents a very striking analogy with them, has however very considerable differences from them; besides which, the important uses for which it is destined, and the remarkable utility which it has in many of the arts, have induced me to treat of it in particular.

24. Neither shall I speak here of the nervous texture diffused throughout the whole body, as it will more naturally require to be considered under the article concerning the brain.

Article VIII.

Of the Muſcular or Fleſhy Texture.

1. THE white, ſoft, and membranous textures in general, which have been deſcribed in the preceding article, form collectively a claſs of organic matters well characterized and well diſtinguiſhed from all others; and by ranking it as the firſt in the order of the general ſolid textures, or of thoſe belonging to the whole body of animals, or which are found diſtinctly in all its regions, I obſerve that we muſt refer to three other claſſes all the different matters which embrace the ſame univerſality of organiſm, or contribute to the general conſtruction of all the organs of animals. I place in the ſecond claſs the muſcular or fleſhy texture, in the third the horny texture, and in the fourth the intirely ſolid or oſſeous texture. The preſent article is deſtined for the hiſtory of the muſcular texture.

2. The muſcles, which in their totality and generality comprehend the fleſhy or muſcular texture, are one of the moſt important and moſt uſeful claſſes of organs in the animated machine; in them and by them it is that the power of life executes the different motions which maintain it, or which inceſſantly ſupply its

its wants; it is by means of their contraction, of the irritability or the force which produces this contraction, this shortening of the fibres which brings together those substances to which they are attached, that the animal moves, transports itself in space, slowly traverses the surface of the earth, bounds to some distance from this surface, rises, or supports itself in the atmosphere, advances, descends, rises or dives in the water; it is these which execute the intermitting and concealed motions which constitute life, standing, walking, vaulting, flying, swimming, the flexion, the extension of the different parts, or the sensible action of partial or total locomotion, subjected to the will or those passions which so eminently distinguish the class of organized and animated beings from that of the plants.

3. When we consider the muscles in their relations with the other parts of the body of animals, we find in them a new motive of interest for studying their properties, because the muscular system forms one of the most considerable masses of the animal organization. Their totality occupies a very large space in the economy of the animal: covered by the skin, contained in aponeuroses, covering on all sides the bones which they invelop and adorn, it is they that give form and torosity to the members. Their projecting and protuberant parts, together with the depressions of their intervals, display all the forms which the

the ſtatuary and the painter imitate in their moſt finiſhed works, by the aid of which they preſent to our eyes the majeſty of a god in the Apollo, the expreſſion of anguiſh in the Lacoon, invincible ſtrength in Hercules, vigour and dexterity in the wreſtler, the bloom of youth in the Antinous, or grace and beauty in the Venus.

4. The muſcles are ſupplied with liquids by a great number of blood-veſſels, which wind along their ſurface, and enter amongſt their fibres, by lymphatic veſſels which are alſo ſituated round their fibres and in the interſtices which ſeparate them. We find in them nerves which are diſtributed, and loſe themſelves in their faſciæ; cellular texture with which they are abundantly provided, aponeurotic membranes which ſurround them, tendons which terminate them. Though all theſe parts are only acceſſary to their texture properly ſo called, anatomiſts conſider them as belonging to their organization, and in fact they all contribute to their functions: the cellular texture connects their fibres; the blood-veſſels nouriſh and warm them; the abſorbent veſſels take up the ſuperfluity of their nouriſhment, and carry off the parts that are worn by the vital actions; the nerves convey into them the immediate cauſe of their motions, and the order of the will which commands them, of whatever nature this cauſe may be; the tendons determine their action upon ſuch or ſuch parts; the aponeu-

roſes afford a point of ſupport to their faſciæ. There is alſo fat both on the outſide and in the inſide of their fibres, which are thereby enabled to ſlide eaſily upon one another. The totality and the integrity of theſe different textures, which penetrate them and conſtitute them living organs, are neceſſary to the exerciſe of their functions; and when the one or the other is deficient or ſuffers, the muſcle loſes a part or the whole of its activity: on this account ſome of the anatomiſts have ſuppoſed the muſcles to be formed of cellular texture; others have believed them to be conſtituted of nervous filaments; and ſome have conſidered them only as vaſcular extremities.

5. The analyſis of the muſcles provided with all the organic parts which conſtitute their totality is not, therefore, nor can it be, exact, ſince it confounds a great number of different textures together. If it were true that ſuch was the contexture and the compoſition of theſe organs of motion, we could not flatter ourſelves with the hope of being able to aſcertain their nature, except by the analyſis of each of theſe parts; and when once each of them was well known, nothing more would remain to be done in order to determine that of the muſcle. Formerly the analyſis was confined to the diſtilling of the fleſh, and deſignating the quantity of phlegm, of ſpirit, of volatile ſalt, of oil and of coal which it afforded: we muſt add to this ancient notion, that amongſt the

products

products of the flesh we obtain a remarkable quantity of zoonic acid combined with ammonia, and that the muscle appears to be amongst the animal substances that which furnishes the most of this acid. Geoffroy, the physician, has described the effect of water, and quantity of soluble matter which it takes up by ebullition from a great number of different sorts of flesh, with respect to the nutritious matter contained in each of them. This inquiry is of no value, except with respect to the alimentary property. Thouvenel was the first who endeavoured to ascertain the different principles, or rather the constituent materials of the muscles; for this purpose he employed several processes which had not been practised before him, and which enabled him to give a rather more accurate notion of the nature of these organs. I have since occupied myself with the base itself, or with the parenchyma peculiar to the muscles, and consequently with their real texture, independent of all the substances that are only accessary to it.

6. While it is impossible to insulate the muscular texture properly so called from the vascular and nervous textures, from the sanguineous, lymphatic, adipose liquids that are intimately mixed with it, we must content ourselves, in treating of the chemical properties of the muscle, with investigating and separating those which belong to each of those animal matters in particular, and attributing to the

muscular

muſcular fleſh thoſe only which do not charac-terize theſe matters. This method of excluſion may lead, as we ſhall ſoon ſee, to a ſomewhat accurate knowledge of the nature of the fleſhy fibre. Modern chemiſts have treated the muſcle like a vegetable matter mixed with ſeveral different ſubſtances, which they have endea-voured to ſeparate from one another, firſt by mechanical means, afterwards by chemical pro-ceſſes. As the organ is filled with ſanguineous and lymphatic veſſels, which contain liquids, Thouvenel employed the action of the preſs for ſeparating them. The fluids which he ob-tained were treated ſucceſſively by caloric, which coagulated their albuminous matter, and cauſed their ſalts to cryſtallize by evaporation; and by alcohol, which diſſolved ſome of their ſalts, and a particular extractive ſubſtance, which this chemiſt believed to be peculiar to the muſcles. He made different ſucceſſive ap-plications of water to the reſiduum of the firſt evaporated liquid, in order to ſeparate from it the gelatin and the ſalts; but theſe means did not conduct him to his end ſo exactly as he had hoped; and in fact they preſent great difficulty in the execution.

7. I have ſucceeded better in this analyſis by firſt waſhing the muſcle in cold water, which carries away the blood and the lymph, and which when the fleſh has been cut ſmall and worked with water poured in a ſtream upon its ſurface, ſoon leaves the white muſcular tex-

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ture infulated, mixed indeed with vafcular tubes, nervous filaments, cellular laminæ of which we may afterwards effect a kind of feparation by the aid of the procefs which I fhall indicate. The water which has wafhed and difcoloured the flefh perfectly refembles blood diluted with water; if we heat it, it coagulates and feparates at its furface in brownifh-red flakes, as happens with the colouring part of the blood; at the fame time there are depofited fibrous filaments, in fmall quantity indeed, but which may be diftinguifhed to be fibrin. The liquor (which is little coloured after this action of the fire, and is flightly turbid and milky) when gently evaporated, affords albuminous pellicles, which are feparated, becomes coloured, acquires a tafte fomewhat acrid when it is concentrated, concretes into a light jelly by cooling, and affords, when evaporated to drynefs, a refiduum of a brown-red colour, from which we obtain, by a well-conducted application of alcohol and water employed fucceffively, a fort of fapid extract of which I fhall foon fpeak, with a fmall quantity of gelatin, and phofphates of a foda and of ammonia.

8. We fee that cold water applied to flefh extracts from it, together with the fanguineous and lymphatic liquor, a fmall portion of extractive and fapid matter, which belongs peculiarly to this organ. When the flefh is thus deprived of what it contained of matter foluble in cold water; if we boil it in water, it ftill fuffers an

 albuminous

albuminous fubftance to efcape, which is collected into greyifh flakes at the top of the liquor, and alfo a fubftance which floats like drops of oil at its furface. The flefhy fibres feparate from each other, and the diffolved lymphatic and cellular texture give the water the property of concreting into a jelly by cooling. A well-managed evaporation of this decoction of flefh previoufly difcoloured, ftill exhibits a portion of faponaceous extractive matter, which acquires colour by concentration, with fome traces of phofphoric falts. The product of this decoction is a kind of bad foup, which has not all the properties of that which is prepared with the intire and unwafhed flefh, of which we fhall foon fpeak: however, it differs from it only by its containing fewer principles.

9. After thefe two fucceffive actions, firft of cold water, and afterwards of boiling water upon the mufcles, if each of them has been carried as far as it can go, there remains only a fibrous parenchyma, of a dirty grey colour, and infipid, which fo far from diffolving in hot water becomes hardened by its action; which dries and becomes brittle in dry and hot air, and prefents all the characters of the fibrin of the blood, efpecially its folubility in the weak acids, the property of yielding by the fire much ammoniacal carbonate and a fetid oil; that of affording azotic gas in abundance by the action of the nitric acid, which converts it into yellow fat floating at the furface, and

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oxalic acid diffolved in the liquor. I have concluded, from my refearches concerning this flefhy parenchyma, that it is formed immediately by the blood poured fo abundantly by nature into the texture of the mufcle; that the nutrition of this organ confifts in the feparation of the fibrin; that it is undoubtedly on this account, that not only the blood is very abundant in it, but that it is alfo retarded in its courfe before it penetrates into the interior of the fibres, by curvatures and tortuofities; fince, according to the celebrated Haller, a great number of arteries purfue a tortuous and retrograde courfe, before they plunge themfelves deep into the mufcles. It is under this relation that I have reprefented the blood as liquid flefh, according to the expreffion of the Father of medicine.

10. When flefh is boiled in water without previoufly wafhing it, a large portion of the ferous and coloured albuminous matter feparates in brown flakes, coagulated by the action of the heat, and forms the fcum which is taken off; another portion of the fame matter remains adhering to the flefh, and gives it that brownifh fawn colour which, as is generally obferved, becomes darker by the contact of the air: the water gradually diffolves the gelatinous matter belonging to the cellular and lymphatic texture of the mufcles, melts and feparates the fat which fwims at the furface, diffolves both the phofphoric falts, and a par-

ticular extractive matter, which gives it the clear yellow colour, the aromatic odour, and the rather pungent and agreeable taſte, which every one knows in fleſh broth. This alimentary liquor, therefore, when well prepared, is a ſolution of gelatinous matter, of an extractive animal ſubſtance, of phoſphate and of muriate of ſoda and of ammonia; it moreover contains a ſmall quantity of fatty oil, diſſolved by the aid of the gelatin and of the extract, a ſmall quantity of albuminous matter, and even a ſmall portion of phoſphate of lime.

11. Fleſh broth preſents to chemical examination a ſeries of phenomena, which prove the preſence of theſe different matters. This liquid is ſuſceptible of turning ſour in hot ſeaſons, on account of the gelatinous matter which it contains; acetous acid is then formed in it. Lime-water, or ammonia, produces in it a ſlight precipitate of phoſphate of lime in a white powder; the oxalic acid ſhows the lime it contains by the white depoſition which it occaſions in it; nitrate of ſilver indicates the preſence of muriatic acid; the nitrate of mercury occaſions a white precipitate, which acquires a roſe-colour by drying in the air, and is a mixture of mercurial phoſphate and muriate, coloured by an animal matter. When we ſlowly evaporate the fleſh broth, it aſſumes an orange and brown-red colour, a ſtronger conſiſtence, and a ſomewhat acrid taſte; and, in this ſtate, it is called (in French) *conſommé.*

Moſt

Moſt of the ſoups reduced to this ſtate congeal, by cooling, into a tremulous jelly; thoſe which are made with the fleſh of young animals preſent it the ſooneſt, on account of the large quantity of gelatin which they contain. By continuing the action of a gentle fire, we obtain, after a more and more decided inſpiſſation, a matter which becomes ſolid by cooling, of a brown-red colour, having a ſtrong and acrid taſte, which keeps for a long time without alteration, which melts intirely in hot water, and forms a ſoup which conſiderably reſembles that which is originally made with the fleſh; this is what is called *extract, or tablets of ſoup,* (portable ſoup) becauſe this ſubſtance is poured into the moulds of tin, in which it aſſumes the form of tablets. If we diſtil this extract of broth, beſides the products common to other animal matters, we obtain a conſiderable quantity of zoonate of ammonia.

12. When the extract, or portable ſoup, is prepared for the uſes of life, and for voyages, the pcoceſs is not confined to making a ſoup of ſimple fleſh. The fleſh of the bullock, the calf, and of poultry, are mixed together; to theſe are added ſavoury vegetables, carrots, onions, cellery, ſome ſpices, eſpecially cloves, with muriate of ſoda in ſufficient quantity, ſo that it actually becomes a mixture of ſeveral different extracts, ſeaſoned with ſaline and aromatic matters, mixed with the portion

of

of faccharine matter contained in the vegetables. Accordingly they have a ftrong tafte, and a lively fmell, different from that of mere boiled meat. The portable foup keeps for a pretty confiderable time. However, it becomes altered after fome years; it becomes covered with a white faline efflorefcence; it attracts humidity, and foftens and becomes mouldy at its furface. The true and pure extract of meat would be neither favoury nor agreeable, in comparifon with that of which I have been fpeaking: it is, however, this extract whofe properties we muft examine, in order to make ourfelves acquainted with one of the principal materials of mufcular flefh.

13. The extractive matter taken up from the mufcle by boiling water, is obtained by lixiviating the product of the foup, evaporated to the confiftence of thick honey, with alcohol: this re-agent attacks neither the gelatin nor the moft of the falts contained in this product. By evaporating this alcohol, which is highly coloured, we obtain a brown-red matter, of a pungent and even acrid tafte, and of a particular aromatic odour; when heated a little more ftrongly than is requifite for drying it, it boils and fwells, and affumes the fmell and faccharine tafte of caramel: it appears that it is this which forms upon roaft meat that brown, fhining, and highly fapid incruftation, which is called the *brown (rifolé)*. This extract remains foft in the air, and gives the portable

foup

ſoup its deliqueſcent property. Heated ſtrongly upon a burning coal, it becomes liquefied, ſwells, exhales a white ſmoke, and an acid ſmell. Diſtilled in the retort, it affords water containing zoonic acid and zoonate of ammonia. Its coal contains muriates of ſoda and of pot-aſh; diſſolved in water, it gives it a deep red colour: this ſolution becomes ſour in the air, and partly paſſes into the ſtate of vinegar, depoſiting ſome coal. It ſtill remains to be determined, whether this kind of extract be contained ready formed in the muſcular fleſh, or whether it be not produced by the decompoſition of the fibrous texture, effected by the action of the caloric.

14. The different facts relative to the analyſis of the muſcular texture, which have juſt been enunciated, ſerve to account for what happens to the muſcle, when it is expoſed to the action of different agents in its intire ſtate, and without the different materials having been ſeparated from it. We may thus underſtand, that in the baking or roaſting of meat, the albumen is condenſed, the gelatin melted, the extract dried, the fibrin penetrated with juice is rendered tender, the ſalts are concentrated, and the fleſh, whilſt it aſſumes a brown colour, acquires a taſte and properties very different from thoſe which it has in its crude ſtate. If, inſtead of heating the fleſh ſtrongly enough, and for a ſufficient length of time to bake or roaſt it, we heat it but very ſlightly, and ſo as only to evaporate

evaporate the water contained in it, it dries, becomes coloured, brittle, and may afterwards be preserved for a long time. The acids soften the muscle, and dissolve it by acting upon its fibrous part. The concentrated caustic alkalis alter, melt, and dissolve it, forming ammonia and oil, with which they constitute a kind of soap. Ammonia produces no perceptible change in it.

15. Many saline substances preserve the muscular flesh, and prevent its putrefaction. Thus muscular anatomical preparations are immersed in a solution of alum, in which, however, the flesh is at last altered and converted into a kind of fat. Fixed oil, the butters, and the fats, with which it may be surrounded, or covered, contribute to preserve it; the volatile oils, the resins, the odorous woods, the bitter and aromatic leaves and barks, act also as anti-putrescent, and prevent the septic decomposition of this texture. Tannin dissolved in water also penetrates its fibres, precipitates in them the gelatinous matter, and surrounds them with a layer of tanned matter, which equally opposes their putrefaction. Alcohol contracts and condenses its texture, so that it cannot afterwards undergo that kind of spontaneous alteration which tends to destroy its composition.

16. The muscle left exposed to the air, putrefies very quickly, when the temperature of the atmosphere exceeds 15 degrees. Its component parts at first exhale a faint or musty smell; it

acquires

acquires a livid colour, which grows darker in proportion as the putrid decompofition advances; its texture foftens and melts at the furface into a kind of liquid putrilage; the fmell becomes fetid, ftrong, and ammoniacal; fometimes there is difengaged at its furface a phofphoric light, which fhines both in water and in the air, and fubfifts for feveral fucceffive days. When the whole of the flefh has been equally foftened, diffolved, and turned green by putrefaction, it at laft leaves, continually exhaling a fetid odour, a brown or blackifh refiduum, which, for a long time, is foft and moift, but dries after feveral months into a kind of animal mould, in which we find fome traces of fat, of carbon, and of alkaline phofphate and muriate. When the mufcular flefh experiences the putrefactive motion, after having been immerfed in water, its decompofition gives rife to another product. There is formed a fatty, white, fufible matter, confiderably refembling what is called *fpermaceti*, and which I have already defignated by the name of *adipocire*. This phenomena takes place fo conftantly, as I firft obferved fourteen years ago, in all the mufcles of the carcafes of animals expofed upon the borders of rivers, brooks, and lakes, that I have propofed its re-production in order to procure, from animal remains that are generally thrown away in the country, and even in large towns, a kind of fat which may be of ufe in feveral of the arts. It was undoubtedly from

this

this propofal that Mr. Gibbes has defcribed this new art in the volume of the Royal Society of London, for the year 1797.

17. It ftill belongs to the province of chemiftry to determine the changes which the mufcles experience in different kinds of difeafes which attack their texture, and at the fame time alter their intimate nature or compofition. This art will fhow what happens to them in the diminution of their alterability, in the foftnefs which they fometimes acquire, and which renders them very eafy to be torn, in their acquiring the bright red or light brown colour, which characterizes them in the courfe of other affections, and efpecially in the white colour, and fatty unctuous afpect which they contract in the courfe of long continued paralytic immobility and infenfibility.

18. The difference of the mufcles in the different orders of animals is alfo one of the moft important objects of chemical refearch for the animal philofophy, but unfortunately one of the leaft advanced; for we can fcarcely reckon amongft thefe refearches the firft experiments made more than fixty years ago by Geoffroy upon the nutritive quality of different kinds of flefh compared with each other. The object of chemical analyfis ought to be to refolve the following queftions, the folution of which can be expected from this alone. In what does the mufcular flefh of the mammalia of the chafe, characterized under the name of

black meat or *venifon* by its brown or dark red colour, differ from that of the ordinary mammalia? Are the mufcles of the carnivorous animals different from thofe of the frugivorous? How does the compofition of the flefh of young animals differ from that of the fame animals more advanced in age? Is the white flefh of birds of a different nature from that of the mammalia and from that of the birds with black and odorous flefh, as well as from the oily and hard flefh of water-fowl? What is the comparative nature of the flefh of fifhes, both in the cartilaginous and in the prickly fpecies, of that of the fea and of frefh-water fifhes, of that of the oviparous quadrupeds, of ferpents, of infects, and of the teftacea? All thefe queftions, and many others to which thefe will naturally lead, are adapted to throw the greateft light upon the phenomena of life, of irritability, of the tonic force, &c.

Article IX.

Of the Dermoid Texture, or of the Skin, and of the Epidermoid Texture, or the Epidermis.

1. THE body of the greater number of animals is inveloped, and all its organs are covered by feveral layers of different membranes, which

which are called in general teguments. In man, in whom this cutaneous covering is the moſt perfect and the beſt organized, as it is not only deſtined to contain all the other parts, but alſo to form the ſeat of the ſenſe of touch, which is more or leſs deficient in moſt of the animals; the teguments are compoſed of three membranes or three ſucceſſive layers; the innermoſt, that which is applied immediately upon the fatty cellular texture, is the thickeſt, the ſtrongeſt, the moſt reſiſting: it is the ſkin properly ſo called, or the derma. Above and on the outſide of this firſt tegument is a ſoft, cellular, areolar, mucous layer, formed of a thin net-work, the meſhes of which are filled with a kind of gelatinous texture, in the midſt of which are placed as upon cuſhions, the papillary extremities of the nerves, the ſeat of the touch: this ſecond layer is the reticular texture of Malphighi. Finally, on the outſide of and above this ſecond texture, is applied a fine, tranſparent membrane, dry externally, which covers the nerves, and is known by the name of epidermis. In the animals this laſt covering varies greatly; there is beſides, under the ſkin, a flat muſcle, generally diffuſed over the whole body, which is called the *fleſhy panicula*.

2. Theſe three ſucceſſive teguments differ in the different parts of the body; they are fine and delicate in ſome parts, thicker, and more ſolid in others. The nerves of touch in man

are

are more multiplied and of a more elegant, more regular, and more diſtinct ſtructure at the extremities of the fingers. The derma is in general and in all animals extenſible, perforated with holes which permit the nerves, the hairs, and the extremities of the arteries to paſs through; it varies greatly with reſpect to its thickneſs, its elaſticity, its tenacity, in the animals of different orders and genera. The reticular and mucous texture is more or leſs ſoft, denſe, and thick, according to the parts to which it belongs; it has neither the ſame organization, nor the ſame extent, nor the ſame functions in the animals whoſe ſkin is covered with hairs, feathers, or ſcales. It is charged with a black matter in negroes; and when it has been deſtroyed by a wound or ulcer, this portion of the ſkin remains white in the cicatrix;

The epidermis is an almoſt inorganic membrane; it is compoſed of laminæ or plates diſpoſed in ſuch a manner that their edges cover each other like the ſcales of fiſhes. It is tranſparent, and very thin: it is re-produced very eaſily and very quickly; its place is ſupplied by real hard and horny ſcales in fiſhes, in ſerpents, and in the oviparous quadrupeds.

In general there exiſts no organic texture more varied and more different in itſelf than the whole of the integuments in the different orders or genera of animals. It would require a very extenſive anatomical diſſertation to point out only their principal differences, and theſe

details

details would here be out of place. It may be ſufficient to remark that it is in the diverſity of the ſkin, and eſpecially in that of the extremities and appendages which cover, defend, or arm it, that the principal apparent difference of theſe beings conſiſts, and that this is conſtantly the indication or the ſeat of a more or leſs conſiderable difference in the primitive or interior organs of animals.

3. Inſtead of conſidering all the varied modifications of properties and of ſtructure of the different orders of animals,—modifications concerning which chemiſtry will at ſome future period have as many details and preciſe notions to give as the anatomical deſcriptions furniſh, and which will diffuſe over the arts and the employment of the tegumentous texture in general a light which would in vain be expected from any other ſcience; I ſhall occupy myſelf only with its general compoſition, which preſents more or leſs analogy in all animals. The ſkin of man, and of ſome of the mammalia, will more particularly ſerve me as example; and in treating of the character of ſome other ſkins, I ſhall only endeavour to ſeize their moſt remarkable relations. I ſhall examine more particularly the three different textures of the human ſkin, becauſe it is the moſt complicated in its organization; and I ſhall make it as it were the type to which I ſhall refer the properties of the other ſpecies of cutaneous textures of animals.

4. The

4. The derma, or the ſkin properly ſo called, when well ſeparated from the fat, the cellular laminæ, and the veſſels which adhere to it, as well as from the muſcular fibres with which it is provided in animals, is a thick, hard membrane, capable of being extended, elaſtic, difficult to be cut, preſenting fibres arranged or diſpoſed like the hairs of felt, leaving ſome areolar interſtices between them of a white colour. When it is briſkly heated, it contracts and is agitated; upon burning coals it melts, ſwells, exhales a fetid odour, and is reduced into a coal conſiderably difficult to be burned. It affords by the retort nearly the ſame principles as the fibrous matter, a thick oil, and much carbonate of ammonia. The products are in general very fetid; weak acids ſoften it, ſwell it, give it tranſparency and diſſolve it; the nitric acid diſengages from it much azotic gas and Pruſſic acid, and changes it into fat and oxalic acid: the concentrated cauſtic alkalies diſſolve it, and convert it into ammonia and oil. It is converted by its ſpontaneous decompoſition in water, and in moiſt and fat earth, into adipocirous matter and ammonia, as may be obſerved in burying places. The ſkins of the carcaſes that have been buried for ſeveral years, are found very diſtinct and ſeparate from the ſubjacent parts, preſenting a grey layer, conſiderably greaſy, brittle, and exhibiting all the characters of an ammoniacal ſoap.

5. The

5. The action of water upon the derma is the procefs whereby its nature and compofition are afcertained in the moft accurate manner. The derma, immerfed and kept in cold water, dilates, becomes flightly foftened, fwells, lofes fome of its tenacity, and at length becoming at the fame time thicker, fuffers the hairs which cover it to be pulled out with eafe, after which it becomes femi-tranfparent, and feems to affect the gelatinous nature by this maceration. When the fkin is left for a long time in this fluid, it becomes altered, putrefies, emits a ftrong fetor, becomes like a foft jelly, and affumes an ammoniacal fmell. If, inftead of letting it putrefy in this manner, we boil in it a fufficient quantity of water after it has been fwelled, we fee it melt, diffolve entirely, and form a vifcid, gluey, thick, ropy, and even glairy liquor, which acquires a homogenous confiftence and liquidity when it is boiled for a fufficient length of time. In this manner is formed a real animal mucilage, a jelly which becomes fixed or congealed by refrigeration, and which affords glue by evaporation and concentration. In many of the arts this property is well known and employed with much fuccefs. Different glues are prepared with glove-fkin, eel-fkin, fhreds of the fkins of quadrupeds, of different fifhes, &c. It is eafy by this fingle procefs to find a remarkable difference between the different kinds of fkins. That of fifhes

fishes melts quickly; that of man and of the mammalia, of the bullock and of the horse, do not dissolve, except with the addition of more water, heat, and time; but all of them, when subjected to a sufficient maceration, at last melt in the water, and pass to the state of jelly or glue.

6. When we observe with great attention what happens in this transition of the dermoid texture into the state of gelatin by ebullition in water, we remark that the skin of the bullock or of the horse, which is very analogous in this respect to the human skin, presents, previous to its melting, fibrous or filamentous flakes which swim in the liquor, and do not dissolve without much difficulty, whilst another portion has been dissolved by the first impression of the boiling water. Hence it has been concluded that the dermoid texture is composed of two principal matters, the gelatin and the fibrin. Citizen Seguin, who has much occupied himself with the analysis of this texture, with a view towards determining the theory and perfecting the art of tanning skins, has formed more mature notions relative to its composition than chemistry before possessed respecting this object. According to him, the cutaneous fibre, being very analogous to the sanguineous or muscular fibrin, is only a kind of oxigenated gelatin, incapable of being combined in its fibrous state with water and the tannin principle: it is necessary to unburn it as it were, or to deprive it of a

portion of its oxigen, in order to render it fusceptible of uniting with the tannin. It appears that a fimilar difoxigenation takes place in the long and fucceffive action of cold and of boiling water upon the derma, fince from having been fibrous and infoluble at firft it at laft becomes intirely foluble and gelatinous. The effect of the great and fpeedy folubility of the fkins of fifhes and of oviparous quadrupeds, and the facility with which they form jelly, as well as the large quantity which they afford, is in favour of this idea of the oxigenated nature of the derma, fince it appears to approach the nearer to the gelatinous ftate as it belongs to animals that refpire lefs, that require lefs atmofpheric oxigen, and whofe blood is the leaft heated.

7. The obfervations and experiments which Citizen Seguin has made upon tanning, having led him to this theory of the nature of the texture of the fkin, it is neceffary to give the refult of his experiments in this place. The precipitate of glue or of pure gelatin by tannin is brittle, and if the derma were purely gelatinous, tanned fkins would be equally brittle. The fibrous texture of the derma does not combine with the tannin ; but when we caufe it to return to the gelatinous ftate by taking oxigen from it we render it fufceptible of combining it with tannin. This is what is done in the preliminary clearing, foftening, and fwelling of the fkins before they are fubjected to the tanning operation

tion. The fibrous part and texture of the derma being of an irritable nature, the action of the weak acids or alkalies causes the small hollow filaments of these fibres to contract and thicken, till, by this action itself, this property is exhausted by the effect of shortening, which diminishes the length, and increases the thickness of the derma. Its gelatinous part is dilated, divided, easy to be dissolved and actually dissolved in the water with which it is soaked; at the same time that its fibrin, dilated and shortened, is unburned by losing a portion of its oxigen. In proportion as it is disoxigenated, it combines with the tannin which is deposited in it: it must not be too much unburned, nor return to the state of pure gelatin; which would render it over-tanned and too brittle: it is on this account that in the swelling, the portion of gelatin which it contains is taken from it. The gallic acid which exists in the tanning water, already exhausted of tannin by the skins, and which is discovered in it by its precipitating the sulphate of iron in the black state, particularly effects this decomposition of the fibrous part of the skin, as we see it effect the disoxigenation of silver, of gold, and of several other metals when we pour it into their solutions: it is on this account that the exhausted tanning water is so useful for the swelling and unhairing of the skins. Finally, the fibrous derma, thus unburned, shortened, irritated and afterwards combined in a semi-gelatinous state with tannin,

having loſt its irritable property and primitive nature, can no longer be ſhortened nor change its dimenſions. However this tanned compound which in good leather is not real tanned gelatin, may ſtill be elongated and flattened, and preſerve a ſort of ductility under the hammer of the ſhoemaker who beats and works it; but it keeps, like the metals, the dimenſions which it has acquired by preſſure.

8. We may therefore draw the following inferences from theſe ingenious obſervations relative to the nature of the derma: that it is in general formed of two textures or two diſtinct matters; the one of which is gelatinous, immediately ſoluble in water and immediately precipitable by tannin: this is extracted from the ordinary ſkins of quadrupeds before they are tanned. The other matter, the true ſolid, extenſible, elaſtic, irritable texture of the ſkin of man, of the mammalia, and of the birds, is the fibrin or oxigenated gelatin; it contains the former in its meſhes; it contracts in one direction and ſwells in its length by the action of the ſaline ſtimuli; it is unburned by the acids, by long expoſure in water, and by ebullition; it returns to the gelatinous or ſemi-gelatinous ſtate according to the proportion of oxigen that is taken from it. It is undoubtedly in the proportion of theſe two matters that the difference of the two kinds of ſkins conſiſts, which is variable according to the nature of the animals, their manner of living, their very high or very low degree of oxigenation, &c.

9. The

9. The reticular texture of Malpighi, or the mucous net-work ſituated immediately upon the ſurface of the derma, and which contains the nervous papillæ deſtined for the perception of the touch, appears to be compoſed of two different ſubſtances ; a ſoft gelatinous covering extended over the whole ſurface of the ſkin and very light, and very fine granulated tubercles, which are nothing elſe than nervous expanſions. Chemical analyſis has not been able to operate upon this texture, as it is ſo fine and delicate, that it cannot be ſeparately detached, and ſeveral anatomiſts have denied its exiſtence, not having been able to diſcern it, even with the aid of ſtrong magnifying glaſſes and microſcopes. It is ſuppoſed that the black colour of the negroes has its ſeat in this texture, and that it depends upon a colouring matter diffuſed in it, becauſe this black ſubſtance may be removed by means of ſolvents without touching the derma and leaving it white, and becauſe the layers of the epidermis when ſkilfully ſeparated are tranſparent and colourleſs. Nothing has yet been done with reſpect to the colouring matter of the ſkin of negroes, neither do we know what is its nature ; we know however that it is capable of being diſcoloured and paſſing into a yellow tinge by the contact of the oxigenated muriatic acid. A negro who had placed his foot in a ley of oxigenated muriatic acid, and held it for ſome time in that liquid, preſented the part almoſt diſcoloured and inclining to whiteneſs ; but a black colour

as beautiful and as pure as that which it had before was entirely formed at the end of ſome days.

10. The ſcaly, dry and tranſparent texture of the epidermis in man proves by its mere aſpect, that it differs remarkably from that of the cutis: it is far from being ſo diſtinct in the animals. When the human ſkin is boiled in water, according to the obſervation of Citizen Chaptal, it firſt grows tough, and ſeparates into two diſtinct parts: the leather, or the cutis, which contracts, thickens and acquires the conſiſtence of a ſoftened cartilage; and the epidermis, which does not diſſolve, whereas a continued ebullition changes the cutis into a gelatinous mucilage. Alcohol does not attack the epidermis, even when kept for a long time in digeſtion upon this membrane. The cauſtic alkaline leys diſſolve it with eaſe. The ſame ſolution is obtained with lime water; but this ſolution does not take place unleſs during of a much longer ſpace of time than that which the pure alkali requires: this we perceive even in rubbing a cauſtic alkaline ley between the fingers; for it aſſumes an oily conſiſtence and feel, in proportion as the ley acts upon the epidermis which it diſſolves. Citizen Chaptal finds in thoſe properties an analogy between the external epidermis of the human body and the matter which covers ſilk. He obſerves that when a ſkin, provided with its epidermis, is immerſed into a ſolution of tannin, the

the latter only penetrates it on the flesh side, and that the epidermis, which does not combine with this substance, prevents its passing from the side of the hair or grain side. In the unfleshing, the epidermis is removed from the skin, which then admits the tannin at both its surfaces; and the lime, which is generally employed in this operation, acts as a solvent of this exterior membrane. Lime-water, on account of the small quantity of the earth which it contains, acts but very little, and requires to be renewed in order to separate this external membrane.

Article X.

Of the Corneous Texture, of the Hairs, and of the Nails or Hoofs.

1. SCARCELY any part of the surface of the human body is entirely destitute of hairs; indeed they are well marked and in considerable quantites only in certain regions, especially the axillæ, the pubes, the linea alba, the front of the breast, the region of the shoulder blades, the thighs and legs, the back of the hands, part of the face, of the chin, and the upper part of the neck. There are some individuals in whom almost the whole surface of the body is hairy, but these are in general

general rare. The palm of the hands, the ſoles of the feet, the red part of the lips, the ſurface of the prepuce and of the glands, and in general all the parts that are covered with the *epithelium*, are the only part which are conſtantly deſtitute of hair. They are diſpoſed in a regular manner in ſome parts, curved into arches in the eye-brows, bent and projecting in the eye-laſhes, rigid and like ſmall pincers in the noſtrils, when they are called *vibices*; erect and in tufts in the concha of the ears, turned in different directions upon the chin, curled and ſhort upon the pubis, the axillæ, &c.

2. The ſkin of the cranium is provided with long hairs very cloſe to each other, deſtined to deſcend over the forehead, the ears, the back of the head and ſhoulders, when they are ſuffered to grow, conſtituting, like the beard, the natural ornament of man, and a defence againſt the rain, the heat of the ſun, inſects, falls and blows, cold, &c. The hairs of the head have not the ſame ſtructure as thoſe of the other parts of the body, though they are of the ſame nature. Much more tufted and ſtraight, they grow to a much more conſiderable length, and their growth has no real limits. Men differ very much from one another with reſpect to the nature of their hairs; and their races are characterized by hairs long and ſtraight, ſhort, curly or criſped, ſoft or rigid, long or ſhort.

3. The colour of the hairs alſo conſtitutes one of the moſt remarkable differences; it varies

varies in different countries, latitudes, climates, temperatures, ages, and ſexes. The human fœtus has them frequently white; they remain ſo in cold countries: however, in the moſt rigorous climates and towards the poles they are brown. In the fiftieth degree of latitude, according to Haller, red hair was formerly the moſt frequent. The hotter the climates are, the more the hair approaches to the black. An exception to this rule are the Albinos, ſo called on account of their pale-blue ſkin and their milk-white hair. It is generally ſaid, that cold and phlegmatic temperaments that abound in white juices are characterized by very fair hair; that the choleric temperament produces red hair, and the ſanguine black. Whatever be the climate, the hairs conſtantly turn white in old men, and become tranſparent by the dryneſs of their centre. It is alſo commonly ſaid that grief turns the hair white, though moſt phyſiologiſts deny the certainty of this fact. Some diſeaſes produce this effect. In ſeveral animals, eſpecially hares and rabbits, the hair becomes white in the winter, particularly towards their points. The diameter of the hairs of the head has been eſtimated at between $\frac{1}{300}$ and $\frac{1}{700}$ of an inch. Withof counted 572 black hairs in the ſpace of an inch, 608 brown, and 790 fair; ſo that the latter are reckoned to be the thinneſt.

4. The hairs have a very remarkable ſtructure, which has been very well deſcribed by ſeveral

ſeveral anatomiſts, eſpecially Malpighi, Ledermuller, Withof, Chirac, and Haller. Under the cutis, and in the midſt of the fat which diſtends the cellular texture, are implanted in this cutaneous fat which appears to be their true ſeat, oval, flat, reddiſh bulbs, formed of a hard, elaſtic, exterior tunic, and ſupplied by ſanguineous veſſels. The interior of this external integument, which is hard and eaſy to be cut into ſmall laminæ, and from which a more or leſs viſcous ſanguineous liquid flows when it is open or punctured, contains a ſmaller bulb, cylindrical, oblong, hard and white. The baſe of the hair is incloſed in this interior bulb; the hair in it is finer, and ſofter than in its exterior part, crooked and conical. It iſſues from the tube covered with two integuments furniſhed by the membrane of both bulbs. When it has arrived at the pore of the ſkin through which it paſſes, it relinquiſhes its exterior covering, and retains only the interior. In paſſing immediately under the epidermis, it raiſes and puſhes before it this membrane, which ſurrounds it, and thus furniſhes it with a ſecond exterior covering. This ſecond tunic adheres ſtrongly to the proper tunic which the hair receives from the interior bulb: it is tranſparent, hard, and corneous. When we cut this epidermoid tunic, we find the interior texture of the hair compoſed of from five to ten filaments connected together by a mucous and gluey texture; this interior and central texture

of the hair is thick as in the bulb itſelf: it ſhrinks and diſappears by drying.

5. To this ſtructure deſcribed by the anatomiſts, and eſpecially by the illuſtrious Haller, I ſhall add that the exterior covering appears frequently to form ſcales detached from the ſurface of the hair, towards the upper part of each, like ſmall branches diverging from it, and that it is on this account that when we rub a hair between two fingers, it always raiſes itſelf, like the beard of corn, in the direction from its baſe towards its point: ſo that when we paſs this delicate organ between the fingers with a rotatory motion, we may eaſily diſtinguiſh its baſe from its point by the circumſtance that it always moves in the direction of the latter; that is to ſay, it aſcends if the point be placed downwards, and deſcends if it be placed uppermoſt. It is by this ſtructure, which anſwers inſtead of ramifications, and acts as it had very ſhort branches, that Citizen Monge has explained the effect of felting which hairs experience by the mere friction or percuſſion which is applied to them: theſe ſmall filaments become engaged in their reciprocal notches, and are thus ſolidly hooked together by preſſing them cloſe againſt each other. It is alſo evident, according to the ſtructure that has been indicated, that the hairs, viewed by the microſcope, muſt appear like kinds of ſticks tranſparent and ſolid, like ſcales or horn; that when we cut them, and view their horizontal ſection,

fection, or the perpendicular with their axis, they muft exhibit a kind of marrow at their centre; that this central medullary texture, proceeding from the interior bulb, muft, by drying, leave the membranes alone, tranfparent and dry, and give whitenefs to the hairs; that when they begin to dry they muft fplit at their extremities, and that it is on this account that we frequently find them bifurcated. It is alfo evident, that on account of their double covering, and of the medullary and filamentous centre which they contain, the hairs muft poffefs a certain ftrength, and fupport fome weight without breaking.

6. We may alfo confider the hairs as hollow tubes, or ducts, communicating immediately with the cellular texture, capable of pouring into the atmofphere a vaporous liquid, or one fufceptible of diffolving in it, and conftituting a particular emunctory. They are capable of impeding the electric fluid, and of infulating thofe bodies which they cover, as filk does. They poffefs, like many animal textures, the hygrometric property in fo marked a degree, that they are employed for conftructing hygrometers in preference to all others. It is on this account that the hair fo readily lofes its curl by the contact of water, of dew, or of fogs. The hairs dry and fall off in difeafes; their bulbs are frequently deftroyed by depraved ftates, or ulcerations of the cellular texture. They fwell and become painful, though infenfible in their pro-

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per texture, by the effect of the *plica polonica*. Their diameters, being augmented in this affection, permits the blood to flow out by their extremities; and it is upon this principle that we are to account for the drops of blood, or the hæmorrhages, which follow the cutting off the hair in this terrible malady. Finally, the hairs receive ſuch an influence from external bodies, that the perſons who work copper have them coloured green by the oxide of this metal, even in their interior part, and not merely in their external layers.

7. After having deſcribed the ſtructure and the phyſical properties of the hairs, we muſt occupy ourſelves with the examination of their chemical properties. Formerly the analyſis of theſe bodies was attempted by the action of fire: Neuman having treated a pound of hair in the retort, obtained from it five ounces and ſix drachms of urinous ſpirit, two ounces and one drachm of concrete volatile ſalt, three ounces and ſix drachms of oil, four ounces and three drachms of caput mortuum, containing twenty one grains of ſalt. But notwithſtanding this kind of repartition of the products of ſix ounces of diſtilled hairs by Neuman, it is evident that his analyſis was far from being exact, as he intirely neglected the elaſtic fluids which are diſengaged in abundance from diſtilled hairs, and of which he had taken no account; and as he found again the total weight,

weight, it cannot be doubted that he was obliged to suppose the quantity of some of the liquid products, which he alone collected, to be more considerable. We shall see, by the exposition of a more recent analysis, that there are still other errors in that of Neuman.

8. It is to Citizen Berthollet that we owe this second analysis, which is much more exact than that of Neuman, though the French chemist published it in 1776, in his *Observations upon the Air*, at a period when the analytical processes were infinitely less advanced and perfected than they are at present. Two ounces of hair afforded Citizen Berthollet one drachm and eighteen grains, or, nearly a thirteenth of their weight of ammoniacal carbonate; two drachms and a half, or more than a sixth of their weight of water, having a very strong smell of burned hair, and ammoniacal from the commencement of the distillation; four drachms, or a fourth of their weight of an oil, very different from that which is obtained from the other animal substances: and lastly, there remained four drachms and a half, or more than a fourth of their weight, of a coal, the particles of which were very sensibly attracted by the magnet, and which he was not able to calcine. This chemist, is estimating at a drachm and a quarter the portion of water, of oil, and of ammoniacal carbonate lost, states at two drachms and eighteen grains the elastic fluids disengaged,

gaged, the nature of which he has not indicated, and which are manifestly carbonated hidrogen gas, mixed with carbonic acid.

9. In the account of this analysis, he insists particularly upon the oil afforded by the hairs, on account of its large quantity, as well as of its very remarkable properties, and its difference from all the other oils obtained from different animal substances. This oil was yellow at first, and became black only at the end of the distillation. It did not alter the colour of the ammoniacal carbonate; it was very soluble in alcohol; it burned with the scintillation and vivacity which every one remarks in the intire hairs when burning; it remained in a concrete form till the eighteenth degree of Reaumur's thermometer: its weight was not much different from that of the water charged with ammoniacal carbonate obtained in this analysis; so that when fluid it swam at the top, and when concrete it sunk to the bottom of this liquid. He concludes from these observations, that the hairs are principally composed of oil; but this conclusion, which might be admitted still in 1776, but which can no longer be considered as exact, must now be considered only as a simple proof of the great disposition which the hairs have to assume the oily character, as is proved in fact by their violent inflammation, their fusibility, their fatty nature, and the impracticability, not only of dissolving them in water, but even of wetting them. It

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is alſo to be obſerved that this opinion of the learned French Chemiſts accords with that of Haller, who, in his great phyſiological work, remarks a ſingular analogy between the hairs and the fat, the conſtant ſituation of the former in the latter, and the frequent circumſtances of morbid fatty concretions, or ſteatomes filled with hairs.

10. The quantity of carbonate of ammonia afforded by the hairs appeared ſo conſiderable to Haller, and ſtruck his attention ſo forcibly, that he was aſtoniſhed that J. Godard, who deſcribed the ſecret of the preparation of the Engliſh drops bought by Charles II. King of England, employed ſilk and not hair, which, he ſays, would have more eaſily afforded him an abundant quantity of this ſalt. This ſame abundance led Citizen Berthollet to doubt in 1760, whether the volatile alkali did not exiſt ready formed in the hairs; and it is certain that no animal ſubſtance affords it ſo abundantly or ſo quickly. It is likewiſe very remarkable that its coal is ſo difficult to be burned, and that it contains a very ſenſible quantity of iron attractable by the magnet. We ſhould be tempted to believe, according to this fact, that the hairs contain in their interior the colouring part of the blood, and that their coal, like that of this colouring part, contains phoſphate of iron. This coal is hard and brilliant, adheres ſtrongly to the glaſs, and reſembles carbonate of iron: there is reaſon to believe that this coal is
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alſo charged with phoſphate of lime; for Citizen Vauquelin and myſelf have found this ſalt in the hairs of the horſe and in the claws of ſeveral animals; and theſe parts have the moſt perfect analogy in their nature and compoſition with the human hairs. There is alſo a little carbonate of lime in the aſhes of hair; black hair even appears to afford more of it than fair.

11. The hairs are thoſe parts of the human body that endure the longeſt; they do not contain the ſame principle of decompoſition and of change of nature which exiſts in moſt of the other animal ſubſtances; they are more durable even than the bones; and in ancient ſepulchres in which the ſkeletons were reduced to powder, or intirely deſtroyed by the action of water and air, the hairs ſtill ſubſiſt, after having reſiſted the efforts of ages, and atteſt that human bodies had been depoſited in them. It is very eaſy to conceive that this preſervation depends intirely upon the corneous inſoluble nature of the hair, and that not being alterable either by air or water, which gradually melt and attenuate all the other animal ſubſtances, they retain their properties and their compoſition even in the midſt of the deſtruction which ſeizes upon all the organic parts. Garman in his Treatiſe *De miraculis mortuorum*, adduces a great number of facts and obſervations which prove this indeſtructibility and inalterability of the hairs.

12. Though ſo little alterable, the hairs are however not exempt from the impreſſion of ſeveral re-agents which more or leſs change their nature. Strong ebullition in water, frequently employed in the arts in which theſe bodies are worked, cauſes them to undergo a ſoftening and partial fuſion, the firſt ſigns of which are peceived in the hygrometrical action which cold water exerciſes upon them. Some perſons even pretend that when they are boiled for a very long time, they become intirely melted in the water and form a jelly; others aſſure us that it is only a portion of the covering of the hair, and not its proper interior ſubſtance, which diſſolves in the water, and affords the gelatin which is obtained from it. No chemiſt has hitherto examined this action with ſufficient attention. The decoction of hair is always coloured.

13. The acids alſo ſoften the hairs and diſcolours them: the muriatic acid whitens them at firſt, but they become yellow by drying; the nitric acid gives them a golden colour. The alkalis diſſolve them very well and reduce them to the ſtate of a kind of reddiſh liquid ſoap, diſengaging from them ammonia and approaching them to the oily ſtate. The metallic oxides in general burn, and conſequently blacken the hairs: they are frequently employed for colouring them upon the head. Thus when they are rubbed or impregnated with fat charged with red oxide of lead and lime, they become black

at the end of ſome days. There are alſo employed for this purpoſe acetite of lead, ſometimes even nitrate of lead, or the nitrates of mercury and of ſilver. After the uſe of theſe metallic ſolutions, the hairs are rubbed with oil, and become ſtill blacker by its contact. In all theſe phenomena hair greatly reſembles ſilk, more eſpecially the horns of the mammalia, the ſhell of the tortoiſe, &c. Thoſe properties which have been deſcribed relative to the epidermis alſo exhibit a great analogy with the texture of the hairs.

14. The nails, which anatomiſts juſtly conſider as a prolongation of the epidermis, and like this laſt, cover a mucoſo-nervous and papillary texture, grow, lengthen, and are renewed without limitation, as is exemplified upon the fingers of the Faquirs of Malabar. Duverny has compared them with horn, and Ludwig with hair, and in fact they are of a very ſimilar nature or compoſition. They ſoften by long maceration and decoction in water; this decoction is rendered but very little turbid by tannin,—ſtill leſs than that of the hair; they cannot be completely diſſolved. They diſſolve in the acids, are melted in the alkalies, are coloured and burned in the metallic ſolutions, and they adhere to colouring matters and are ſolidly dyed, as we may ſee by inſpecting the hands of dyers.

15. It may be concluded from all theſe facts, that the corneous animal texture and eſpecially the matter of the epidermis, of the

hairs and of the nails is an oxigenated gelatinous ſubſtance, little or not at all ſoluble, rendered ſolid, elaſtic, unalterable and very durable in its intimate nature, not only by its ſtate of oxigenation, but alſo by its union with a conſiderable quantity of phoſphate of lime, and even with a ſmall quantity of carbonate of lime; ſo that theſe concreſcible and little ſoluble ſalts, being depoſited with an oxigenated gelatinous matter exiſt as it were in the ſtate of a tanned ſubſtance. Every fact announces that theſe corneous textures, ſo abundant upon the ſurface of the body of man and of animals, are reſervoirs into which the exceſs of the nutritive matter and of phoſphate of lime is depoſited. The firſt is depoſited in them eſpecially at that period of their life when their growth has ceaſed; the ſecond is collected in them, eſpecially in thoſe animals from which the urine does not carry off this matter of the bones, as I ſhall ſhow in ſpeaking of the urinary liquids and of the oſſeous texture: accordingly, the mammalia of which I ſpeak, have their ſkin intirely covered with hair; whilſt man, whoſe ſkin is almoſt bare, evacuates by urine the exceſs or too great abundance of oſſeous matter.

ARTICLE

ARTICLE XI.

Of the Cartilaginous Texture.

1. THE cartilaginous texture has a confiftence and ftructure which fufficiently diftinguifh it from all others ; it is an almoft folid body, white, of a milky tranfparence, confiderably refembling to the colour of the chalcedony or the opal, fufceptible of compreffion, highly elaftic, eafy to be cut, fmooth and polifhed in its fection, like a refinous matter, granulated or like fhagreen in its fracture. It has not the hardnefs of the corneous texture, but is intermediate between this fubftance and the ligament. The cartilages are moft frequently fituated at the articular extremities of the bones which they cover, and into the texture of which they enter, or between bones which they keep afunder and foften their friction, whether they be moveable or fixed. Sometimes they conftitute particular kinds of organs, as in the human larynx.

2. The ftructure of the cartilaginous texture is difficult to be determined and defcribed, and Haller acknowledged that it was much more obfcure than that of the bones. It is not diftiuguifhed from the latter in the fœtus. Its difference from the offeous texture is very flight in

in thofe of the larynx and of the ribs; it is feldom or never converted into offeous texture in the two parts of the larynx and the ribs. In fome cartilages we fee, in the interior, a fort of core, or granulated texture, covered with a whiter and finer matter: it is very difficult to difcern laminæ or fibres in this part. The tendons that undergo a ftrong preffure, become converted into cartilages, like that of the peronæus longus in its paffage under the cubiform bone: the thyroid gland, the tunics of the large arteries, the fides of cyfts and of aneurifms frequently become cartilaginous. The firft rudiments of the bones in the human body are real cartilages; in the adult, and by the progrefs of offification, they have only a flight cartilaginous cruft at their extremity. The articular and inter-articular cartilages never become offified, on account of their continual humectation. The intervertebral cartilages formed into ligamentous rings at their extremity, and into a glutinous, thick, white humour, fimilar to a flakey ftarch, at their centre, become offified but very rarely.

3. Some familiar and domeftic facts are well adapted for affording a notion of the chemical nature of cartilage. It is known that this animal matter foftens in water; that, by its foftening, the laminæ, or the fibres which enter into its ftructure, become perceptible by fwelling, fplitting, detaching themfelves from the offeous furface in their divided part; that they affume

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the gelatinous nature by long ebullition, and the transparency which characterizes this substance. These phenomena present themselves at the extremities of the bones which accompany the meat which we boil, and many persons prefer these cartilaginous parts when softened and converted into jelly by boiling. Hunter, one of the anatomists who have occupied themselves the most with the nature of cartilage compared with several other animal parts, has collected several experiments by which he has endeavoured to prove the difference of its texture from that of the bones. According to his experiments, the cartilages are not softened in the acids; they dissolve completely in hot water. They are not coloured like the bones, or along with them by madder mixed with the food of animals.

4. To these characteristic properties it is added, that the cartilages do not exfoliate in diseases; that they do not soften like the bones; that they are not re-produced after having been destroyed. These comparative observations we owe to Hunter. Haller concludes, from a comparison of these facts, that cartilage is formed of thickened gluten, into which it may be converted by art; that this gluten receives, as it becomes concrete, a slight portion of calcareous matter, or of phosphate of lime, which renders it solid; that it is on this account that cartilaginous texture is formed in the sides of the arteries, in the membranes of the spleen, in the

the thick part of the pleura, of the pericardium into which a glutinous humour is poured; that their ossification, which takes place in some cases, or with very old subjects, depends upon a too great quantity of calcareous matter, which is precipitated and collected in their vascular texture, as well on account of its known superabundance in old persons, as by the dilatation of the vessels which convey the nutritive juice. This great anatomist concludes from the analogy of the cartilage with the bones, that there must exist in the one as well as in the other, fibres and laminæ, but that they are concealed by the opaque and homogeneous gluten, which covers them on all sides.

6. While borrowing these general considerations from the immortal work of the Helvetian physiologist, I have endeavoured to supply the silence of the chemists respecting the nature of the cartilages: I do not know of any particular analysis having been made of them. If what Haller advances were perfectly exact, it would follow that the cartilages are of a composition similar to that of the corneous texture; but this analogy, at least if taken in all the latitude in which it is here presented, is not probable, because the mere aspect of the cartilaginous texture, its living properties, and its morbid alterations, prove that there exists a very remarkable difference between the two textures. We must indeed admit the presence of the phosphate of lime

lime in cartilage, as well as in the corneous texture; but it appears, that besides a remarkable difference in the proportion, the gelatinous matter of the first differs from that of the second by a modification, which chemistry is alone able to determine, and may throw much light upon the very imperfect knowledge we yet possess of the intimate nature of cartilage.

Article XII.

Of the Osseous Texture.

1. THE system, or the totality of the bones, which support the whole animal machine, and give its general figure, its size and its firmness, forms the last solid texture which remains to be examined; for the bones are the last parts which we find in the order of dissection; those which constitute the last term of nutrition, and into the nature of which several of the preceding textures pass. There exists in the animal economy a power which tends to produce the osseous matter, and to deposit it in most of the other organs. Accordingly, the natural termination of life in animals seems to depend upon this ossification which predominates over the other functions, and opposes their exercise. The bones constitute one of the parts the

the moſt generally diffuſed throughout the whole continuity of the animal body, for here is no region of which the baſe is not a ſolid or oſſeous organ. They muſt, therefore, be reckoned amongſt textures belonging to the whole animal economy, and performing one of the principal functions of life which ſupport its exiſtence.

2. All the bones being connected together by ligamentous fibres, united and articulated, form a ſyſtem ſubdivided and moveable in a great number of points; without being removed or ſeparated in the healthy ſtate; they conſtitute all together what is called the ſkeleton. Their ſolidity, their white colour, their elaſticity, and their denſity, diſtinguiſh them ſufficiently from all the other organs. In order to characterize them, they are diſtinguiſhed, amongſt the numerous bones which form the ſkeleton, into the flat, the long, the cylindrical, the cubical, &c. We obſerve in them poliſhed ſurfaces, cavities, eminences, or apophyſes, depreſſions, impreſſions, aſperities, grooves, ſinuoſities, canals, which, whilſt they characterize each in particular, remind us, by their mere aſpect, of their relations, and contiguities with many other parts, with the uſes for which they are deſtined. Their extremities generally preſent projecting or excavated ſurfaces, fittings, heads, cavities, condyles, pullies, either naked or more frequently covered with cartilages deſtined for uniting them cloſely with the contiguous

tiguous bones, or permitting them to move, to ſlide upon each other, and to change their reſpective ſituation more or leſs conſiderably. In young animals, the bones are more numerous, many of them being ſeparated into ſeveral others, and preſent detached or diſtinct parts, which are called *epiphyſes*. Theſe ſeparated parts diſappear with advancing age, and the bones even adhere at ſeveral points to one another, ſo that in old age the ſkeleton tends to form only a ſingle piece. All the bones are covered with a membrane which adheres very ſtrongly to them, in ſeveral very diſtinct laminæ, and is called the perioſteum. Anatomy occupies itſelf with this external ſtructure, with the deſcription of the bones one after the other, in ſo accurate and detailed a manner, that great part of the works upon this ſcience is conſecrated to it, beauſe it is conſidered as the baſe of all the other parts of anatomical knowledge. The inſtructed eye, on ſurveying the ſkeleton, ſoon applies to it all the other parts, ſo that it becomes the type upon which memory raiſes, as nature herſelf ſeems to have done, the whole edifice of the animal body.

3. The internal ſtructure of the bones is no leſs important to be known than their ſurface and their figure, eſpecially in order to arrive at the determination of their intimate nature or compoſition. Theſe ſolid organs appear, when broken, to be formed of laminæ applied

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to each other, ſometimes very cloſe and compact, as in the centre of the long bones, ſometimes ſeparate, and leaving between them porous cavities, preſenting ſmall veſicles, like thoſe of a ſponge: accordingly, this latter texture is called ſpongy or cellular. The flat bones are, in general, formed of two tables, having a ſpace between them, and ſupported by ſome ſolid fibres paſſing out of one table into the other; the intervening ſpace is filled with a reddiſh ſoft texture, which is called *diploe.* In the long bones, there is a medullary cavity or canal, full of a kind of fat called *marrow,* which is depoſited in a cellular membrane detached from the interior perioſteum, and itſelf ſupported upon ſome oſſeous laminæ, or ſome filaments detached from the internal ſurface of theſe bones; blood-veſſels which perforate the body of the bone obliquely arrive at this internal perioſteum, and pour into it the liquid which nouriſhes them. The middle part of the long bones is compoſed of very cloſe laminæ, forming a conſiderable thickneſs: towards the extremities theſe laminæ diverge from one another, ſeparate, and form by their ſeparation oſſeous cells, which conſtitute the whole thickneſs and the whole ſtrength of the heads of the bones; ſo that theſe dilated extreme parts, which are very thin in their external oſſeous layer, nevertheleſs reſiſt a great degree of preſſure by the conſiderable number of plates and of ſolid columns which bear upon

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the internal surface of the layer. The cellular texture of these dilated extreme parts, or of these heads, of these condyles of the long bones, is filled with a juice analogous to the diploe which is found between the tables of the flat bones. However close the laminæ of the bones may be in their solid part, they nevertheless easily suffer a part of the medullary oil placed in their interior cavities to insinuate itself between them. The bones have an elastic texture susceptible of a certain degree of extension, of a certain elongation before it breaks.

4. The external and internal structure of the bones has been known much earlier than their intimate nature or composition. Exact and even minute descriptions of their surfaces, their slightest inequalities, of all their parts, were already completed; the great works of Vesalius, of Columbus, of Riolanus, of Clopthon-Havers, of Albinus, of Monro, of Bertin, and of many other celebrated anatomists, had brought this descriptive part to its perfection; many curious researches had even been made upon osteogeny or the formation of the bones; and the valuable discoveries of Kerkringius, of Duhamel, of Fougeroux, of Haller, of Troja, &c. had already thrown some light upon this beautiful part of physiology, before chemists had discovered the real nature of these organs. Till 1774, we contented ourselves with distilling the bones, determining their products in an

inaccurate

inaccurate manner, loofely ranking their bafe amongft the earths, though it had been fufpected that it had conftituted a particular earth. Papin, Heriffant, Laffone, Haller, had carefully diftinguifhed and proved by experiments that the bones were formed of two different fubftances; the one glutinous, fufceptible of diffolving in boiling water, and forming a jelly which was prepared for the ufes of feveral of the arts; and another fubftance which had been confidered as calcareous or abforbent; when one of thofe capital difcoveries, which tend to change the afpect of the fcience, was made by two Swedifh chemifts. Gahn and Scheele proved, by exact experiments, that the pretended offeous earth was an earthy falt compofed of phofphoric acid and lime, which could not confequently be converted into lime by the action of fire, nor faturate the acids after the manner of an ordinary abforbent earth. This difcovery was foon confirmed by a great number of chemifts, efpecially in France, where the procefs of the decompofition of the bones, as well as the art of extracting the phofphorus, was fimplified by Rouelle the younger, Macquer, Poulletier de la Salle, Nicolas de Nancy, and Berniard. It will foon be feen that by a late courfe of inquiries made by Citizen Vauquelin and myfelf in conjunction, we have added a new degree of precifion to the analyfis of the calcareous phofphate of the bones.

5. The

5. The bones expofed to fire in contact with the air, if we begin by a mild temperature, firft dry and become brittle; then a fatty oil efcapes from their interior and turns their external layers yellow. To the aqueous vapour which is firft exhaled, fucceeds, when the action of the fire is augmented, a fetid and greafy fmell; the furface of the bone becomes brown, a thick white vapour is difengaged from it; it then takes fire, and continues to burn till the whole of its oil is diffipated. The bones are then black and in the ftate of coal when they are fuffered to cool; but when they are heated to rednefs, their coally matter burns from the furface to their internal part, and they are at laft changed into a white friable fubftance, infoluble in water: fuch are the calcined bones which are ufed in the arts for rubbing and polifhing diamonds, and forming cupels. Thefe calcined bones, lixiviated in water and by the acids, afford a little carbonate of foda, carbonate of lime, and a large quantity of calcareous phofphate. The proportion of this faline earthy fubftance, with refpect to the whole bone, is 0,65 as the average term of many varieties with refpect to the age, the ftate of this organ, its folidity, &c. If we heat the calcined bones to an intenfe rednefs, they experience, at the fame time emitting a yellowifh, phofphoric light with which they feem to be penetrated, a femi-fufion which affimilates them to the ftate of porcelain. They have a fine clofe

close semi-vitreous grain, a great degree of density, a semi-transparency, and that soft aspect which belongs to all the vitrified earths.

6. When we treat the bones in close apparatuses, distil them in a retort, from the mildest temperature which is usually employed in these operations to the most intense heat which these vessels can support, we obtain water which gradually assumes the oily ammoniacal colour and smell, oil partly liquid and light, partly heavy and concrete, of a brown-red colour, very fetid; carbonate of ammonia dissolved in water and in a concrete form, soiled by a portion of oil, a carbonated and sulphurated hidrogen gas, and carbonic acidg as. There remains in the retort a coal which retains the form of the bone that has been put into the vessel. When we carefully examine the water which is obtained in considerable abundance in this distillation, we find in it, besides the ammoniacal carbonate, a small quantity of sebacic and of Prussic acid combined with ammonia: the thick oil, separated from the other products and subjected to rectification, becomes in part liquid, volatile, of an almost aromatic smell, and in every respect similar to what is called *Dippel's animal oil;* it is always a little ammoniacal, and turns the syrup of violets green. The coal calcined in open vessels heated to whiteness, affords the same results as those which have been enunciated in Article 5. Formerly the products of the distillation of the bones were

4 employed

employed in medicine, and thoſe obtained from the human cranium, or from the horns of deer, were preferred. It is very evident that theſe products of the combuſtion and of the diſtillation of the waters, with the vapours, the inflammation, and the liquid and gaſeous products, are owing to the gelatinous or truly animal portion of theſe parts; for the earthy ſalts can neither be their cauſe or their ſource.

7. Bones expoſed to the air gradually become dry, brittle and arid; they become white when they are long expoſed to the dew; and afterwards turn yellow, eſpecially by age and during hot ſeaſons; whilſt they thus acquire colour, they become greaſy and oily at their ſurface. After a great length of time having been turned brown by a kind of ſlow combuſtion, they decay, ſeparate into ſmall ſcales, and fall into powder. It is in this manner that they are gradually deſtroyed in the fields and in burying places; but ages are ſcarcely ſufficient to effect this deſtruction. I have examined ſome that had remained nearly three hundred years in a charnel-houſe, defended indeed againſt the rain, which were ſtill very hard and elaſtic, and contained their gelatinous part almoſt entire. Van Swieten mentions a ſkeleton kept in his muſeum, the bones of which were ſpontaneouſly deſtroyed, and fell into powder by the effect of a virus which, according to him, ſtill exiſted in this ſubject, and re-acted upon the texture and the compoſition of its

 bones.

bones. It is known that these organs receive, and easily promote the germination of small seeds of vegetables which cover their surface with a greenish moss; that when buried in the ground, they admit carbonate of lime into their pores, which the water deposits between their layers, at the same time depriving them of a part of their gelatin; that they are sometimes incrusted with it, and improperly take the name of *petrified bones;* and lastly, that when penetrated by a solution of oxide of copper, they acquire a green colour, and are called *turquoises.*

8. The action of water upon bones is one of the phenomena which has been the longest known, and which has been employed with the greatest success for determining their nature. Cold water acts but very slowly upon these organs: when they remain in it for some days, it gradually penetrates their pores, divides and separates their laminæ, and softens their gelatinous parenchyma: their medullary juice is easily converted into adipocirous matter. Boiling water attacks their texture, when they have previously been reduced into small fragments, into chips, into powder, or into thin laminæ; it dissolves their white cartilaginous matter, and quickly changes it into very pure gelatin: these bodies are in preference used for preparing the whitest, the most transparent, and the mildest jelly, which is the most ...eptible of receiving all the most varied ..., perfumes, or seasonings. Thus a light and agreeable

agreeable aliment is extracted from hartshorn. Thus ivory and bones afford a nutriment useful in certain circumstances. The gelatinous substance of the bones is softened in these organs in their entire state, when they are subjected to water raised to a temperature much superior to that of its ordinary ebullition, as takes place by the strong compression in Papin's machine or digester, in which the most solid bones are softened in a few minutes. These bodies, thus deprived by the water of their gelatinous substance, become afterwards, when slowly heated, dry, brittle, and friable; and their laminæ separate easily from one another. I speak here only of the action of water upon the osseous laminæ when pure and separated from all that does not belong to them. The proportion of this gelatin, *extracted* from bones by means of water, appears to be from 0,25 to 0,35. If we heat entire and fresh bones in this liquid, their periosteum, as well as the tendons and ligaments which remain attached to it, are dissolved and increase the proportion of gelatin; their marrow melts and collects at the surface in the form of oil. This is the reason why they contribute to the mild and unctuous alimentary quality of broth. The stomach and the digestive power effect the decomposition of bones still better than hot water, and those animals which take them as food, discharge them in a great measure deprived of their gelatinous matter, as is proved by the

chemical analyfis of the excrements of dogs that eat bones, excrements formerly called in the materia medica by the ridiculous name of *album græcum.*

9. It has long been known that the weakeft acids have the power of foftening bones, and of diffolving that part of them which was called *earthy.* Heriffant, in examining this phenomenon with fome attention in a Memoir inferted amongft thofe of the Academy of Sciences of Paris, for 1758, thought he had found in the nitric acid (with which he foftened the bones which he foaked in it, by diffolving their earth, which he believed to be cretaceous, without affecting their membraneous cellular part) a means of infulating the two conftituent matters of thefe organs. Haller has verified this foftening of the bones even by the acetous acid and lemon juice: he fufpected that in the foftening of the bones by the effect of difeafes, there exifted an acid which thus corroded them. All the chemifts have afterwards obferved that a folution of bones in an acid precipitated by alkali affords a feemingly earthy matter, which does not poffefs the property of becoming quick-lime by calcination. It is to Scheele that we are indebted for the true knowledge of this phenomenon. After having, like Heriffant, diffolved bones in the nitric acid, he filtrated the liquor, and afcertained that, though always acid, even when faturated with all that it could diffolve of bone, it precipitated

fulphate

ſulphate of lime by the addition of concentrated ſulphuric acid; and that after this precipitation, the ſolution drawn off clear, and evaporated in a retort, afforded volatilized nitric acid, and left phoſphoric acid, which was fuſed into glaſs by the action of a ſufficient heat. He concluded from this experiment that the nitric acid diſſolved the phoſphate of lime, the baſe of the bones; that the ſolution in this acid was a mixture of calcareous nitrate and of phoſphoric acid; that when the firſt was decompoſed by the ſulphuric acid, and the precipitated ſulphate of lime ſeparated from it, there remained only a mixture of the two acids, the phoſphoric and the nitric, and that this latter mixture, when heated, diſengaged volatile nitric acid, whilſt the fixed phoſphoric acid remained at the bottom of the retort. We ſhall ſoon ſee that things do not happen exactly in this manner: but before we prove this, it is neceſſary that we ſhould give an account of what chemiſts have done reſpecting this action of the acids, between the epocha of the diſcovery of Scheele, and that of our own inquiry, the laſt that has been made to my knowledge upon this kind of analyſis.

10. Poulletier de la Salle and Macquer firſt repeated, at Paris, Scheele's analyſis of the calcined bones, and found it accurate with reſpect to the preſence of the phoſphoric acid in the bones, and the art of extracting phoſphorus from them. Rouelle the younger, when he

alſo occupied himſelf with this ſubject, obſerved ſeveral important facts, and deſcribed them with much accuracy in the Journal de Medicine of the month of October, 1777. Such are, amongſt others, 1. the means of ſeparating carefully, by repeated decantations and filtrations, the ſulphate of lime formed in the proceſs of Scheele; 2. the examination of the liquor after evaporation, by oſſeous or calcareous nitrate, in order to aſcertain the preſence of the ſulphuric acid in it by the precipitation; 3. the portion of ſalt thrown up and not volatilized in the diſtillation of this nitric and phoſphoric liquor, by the jets formed in the thick liquid; 4. the decompoſition of the ſulphate of lime by the concentrated phoſphoric acid; 5. the ſtate of the opaque vitreous phoſphoric maſs remaining in the retort, and preſenting a mixture of this acid, of the ſulphuric, of baſe of bones or phoſphate of lime, and of ſulphate of lime; 6. the difficulty of ſeparating the pure phoſphoric acid from this maſs; the means of effecting this ſeparation by lixiviating, concentrating the lixivium by fire, and adding alcohol which precipitates the phoſphoric acid in white flakes; 7. laſtly, the fuſion of this acid, thus prepared and purified into a very white and very tranſparent glaſs, and the poſitive proof that the earth diſſolved by the nitric acid, and afterwards carried off by the ſulphuric, is really calcareous: a proof which conſiſts in precipitating it from the ſulphate depoſited

depofited by the carbonate of pot-afh, and calcining the precipitate in order to reduce it to the ftate of lime.

11. Citizen Nicolas, a chemift of Nancy, a fhort time after the inquiry of Rouelle, gave a new and much more fimple procefs for extracting the phofphoric acid from bones; a procefs which contributed to elucidate their nature. Upon bones calcined to whitenefs, pulverized, paffed through the fieve, and placed in a veffel of ftone-ware, an equal part of concentrated fulphuric acid is poured; the mixture is ftirred with a fpatula of glafs; and a fufficient quantity of water is added to bring it to the confiftence of thin foup. After fome hours contact and repofe, during which it thickens, the mixture is placed upon a double linen cloth fufpended upon a fquare frame; it is wafhed with water till it ceafes to be acid, and to precipitate lime-water, or till the water has diffolved all the phofphoric acid: the mixed water are evaporated, and by means of the filtre, the fulphate of lime is feparated in filky ftraws or filaments, which are depofited during the evaporation, and muft be well wafhed with a little water. This feparation is continued till the liquor no longer depofits any thing; the concentration is then continued fo far as to give the liquor the confiftence of a foft extract: it is heated pretty ftrongly in a large crucible, in which it fwells and exhales a fulphureous and aromatic fmoke, in order either

to

to give it a ſemi-vitreous form, or even to vitrify it completely into a tranſparent glaſs without bubbles, which cannot be obtained except by keeping it fuſed for a ſufficient time. If it be propoſed to extract the phoſphorus from it, the operation is continued only till it has the conſiſtence of honey; for the phoſphoric glaſs does not afford this combuſtible body without great difficulty.

12. Since the publication of the proceſs of Citizen Nicolas, chemiſts have all contented themſelves with repeating it upon different kinds of bones, in order to compare them with one another, and to determine the quantity of phoſphoric acid which each of them is able to yield. Berniard has thus compared foſſil bones, thoſe of the whale, of the elephant, the porpoiſe, of the bullock, of man, the horns of the elk, the teeth of the ſeal, ivory. Bullion has extracted it from the bones of fiſh and from ivory, from which Rouelle had ſaid he was not able to obtain it. Citizen Vauquelin and myſelf, in our reſearches upon the animal matters, had occaſion to examine with much attention the phoſphoric acid extracted from bones, and to compare it with that produced by the deflagration of phoſphorus; from which it differs in ſome properties. We remarked that that of bones aſſumed by evaporation to a ſolid conſiſtence, the form of pearly ſtraws; that when thus dried, it attracted the humidity of the atmoſphere but very feebly; that

that when fused into glass it was no longer acid, nor hardly soluble; we also found that the calcined bones, dissolved in the muriatic acid, afforded likewise, by spontaneous evaporation, 0,33 of scaly crystals, brilliant, acidulous, fusible into an insoluble glass, becoming very soluble by any acid, and especially by an excess of phosphoric acid; that is, in every respect similar to what is obtained from bones by the sulphuric acid. The nitric, the acetous and the acetic acids, &c. gave us a similar substance with the calcined bones. This matter, which reddens the blue colours, and is precipitable from its solution by ammonia, the caustic alkalis and lime water, into insipid and insoluble calcareous phosphate, presented us with all the properties of an acidulous phosphate of lime.

13. We found by these first experiments that the bones were not completely decomposed by the acids, though they all alike possess the property of softening them and dissolving their solid part; that their phosphate of lime was only in part decomposed; that the acids took from it only a portion of its base, and reduced it to the state of acidulous calcareous phosphate; and that there their action ceased. We afterwards found, by other experiments, that the acidulous phosphate of lime might also be prepared with the base of bones and the phosphoric acid; that this acid, when pure, decomposed the muriate, the nitrate and even the

the ſulphate of lime, leſs indeed than the two firſt, and thus formed acidulous calcareous phoſphate, always cryſtallizable into ſmall brilliant and micaceous ſtraws; that this acidulous phoſphate contained 0,54 of phoſphoric acid, and 0,46 of lime; whilſt the phoſphate of lime, of bones, or the well ſaturated phoſphate, contained 0,41 of phoſphoric acid, and 0,59 of lime; that in treating the latter by the acids, only 0,24 of lime was taken from it; that 100 parts of calcined bones, treated by the ſulphuric acid were charged into 76 parts of acidulous phoſphate, formed of phoſphate of lime 59, and of phoſphoric acid 17 parts; that there were only theſe 17 parts of free acid which afforded phoſphorus in the diſtillation with charcoal; that the portion of neutral phoſphate of lime remained in the reſiduum of this operation, and that it was on this account that from 100 parts of bones, according to the moſt exact calculations of Pelletier, who has given excellent details upon this preparation, only 0,05 of phoſphorus, at moſt, were obtained; whereas the 100 parts of bone really contain 0,16 to the 0,41 of phoſphoric acid which they contain.

14. This knowledge which we acquired concerning the ſemi-decompoſition only of the oſſeous calcareous phoſphate, by the acids, and the formation of an acidulous phoſphate, afforded uſeful reſults for the extraction of the phoſ-

phoſphoric acid of bones, their analyſis, the preparation of phoſphorus, and even for oſteogeny.

Calculation and experiment have taught us that only $\frac{2}{5}$ of their weight of concentrated ſulphuric acid muſt be employed for decompoſing the calcined bones, inſtead of $\frac{2}{3}$ which chemiſts had directed.

In order completely to analyſe the bones, and to aſcertain the proportion of phoſphoric acid and lime which they contain, after having diſſolved their earthy baſe by any acid, as the nitric or the muriatic, this ſolution muſt be precipitated by the oxalic acid, which decompoſes the acidulous phoſphate of lime, like all the other calcareous ſalts, and conſequently leaves the phoſphoric acid nearly free in the liquor, ſwimming above the precipitate which it forms, which containing in 100 parts 0,48 of lime, thus indicates the quantity of this earth. No alkaline carbonate decompoſes the acid phoſphate of lime, nor conſequently can they ſerve for this complete analyſis.

As that which is obtained from bones treated with the ſulphuric acid, yields phoſphorus only in proportion to the exceſs of phoſphoric acid in the acid phoſphate of lime, if we treat the lixivium with nitrate or acetite of lead, we decompoſe completely, and by neceſſary double elective attraction, the acid phoſphate of lime; all its phoſphoric acid is depoſited in union with the lead; all its lime

lime remains in ſolution, combined with the nitric or acetous acid. The precipitate well waſhed, and diſtilled with charcoal, affords a quantity of phoſphorus, more than twice as large as the ſimple product of the evaporation of what was called *phoſphoric acid of bones*; we thus obtain from 0,08 to 0,12, inſtead of 0,05, which had hitherto been extracted.

The very eaſy and abundant ſolubility of the oſſeous phoſphate of lime in the phoſphoric acid, and the ſpeedy formation of acid calcareous phoſphate, explain a ſeries of important phenomena relative to oſteogeny and the diſeaſes of the bones, which are not to be detailed here, but which will be found elſewhere.

15. The cauſtic alkalies, and the alkaline carbonates have no action upon the oſſeous phoſphate of lime, and do not effect any decompoſition of it, though chemiſts have thought ſo, and have even propoſed to fuſe calcined bones with the carbonate of pot-aſh, or of ſoda. It is a fact, of which Citizen Vauquelin and myſelf have well convinced ourſelves, and which we have confirmed by very exact experiments. It will be ſeen hereafter that this impoſſibility of decompoſing the phoſphate of lime by the carbonate of pot-aſh, either in the dry or in the humid way, oppoſed to the facility with which the oxalate of lime is decompoſed by the ſame ſalt, has afforded much light reſpecting the analyſis of ſeveral

kinds

kinds of urinary concretions. The alkalies and their carbonates, in ſolution, act upon the gelatinous matter of the bones, which they thus ſoften, and the extraction of which they favour. No ſalt has any real action upon the oſſeous texture.

The metallic oxides, and their ſolutions in the acids, burn its membranous part more or leſs powerfully, or colour it, at the ſame time penetrating it, when they are diluted with water; in this manner it is that the ſolutions of copper turn the bones that are expoſed to their contact green, and artificial turquoiſes are formed in pieces of bones, ſuſpended in very weak nitrid acid, or even in other liquids, when only a mere pin of copper is at the ſame time immerſed along with them.

16. Amongſt the vegetable matters, if we except the acids already indicated, we know only the oils and ſome colouring matters that are capable of penetrating the oſſeous texture, undoubtedly in its gelatinous ſubſtance, and giving it either an unctuous flexibility, or a ſoft poliſh, or a more or leſs intenſe colour. It is known, relatively to this laſt mentioned fact, how eaſy it is to dye the oſſeous ſurface, and even to cauſe the colour to penetrate conſiderably between their deep-ſeated layers; and alſo how ſtrongly the colouring matter adheres, and what livelineſs it aſſumes in them, as is exemplified in the various toys of ſtained bones which are daily manufactured. We alſo ſee a ſtriking

proof

proof of this adhesion of the colouring matters with the bones in the brilliant rose-colour, which the bones of living animals contract from madder, mixed with their aliments. The fine tinge which this vegetable gives them seems to announce that its colour is brightened by an acid before it is deposited amongst the osseous laminæ.

Amongst animal matters, the fats and the coloured substances act like the preceding bodies upon the bones; the acids which are produced by the spontaneous alterations of these living matters, dissolve the phosphate of lime, and soften the osseous texture as easily as those which belong to the fossils or to the vegetable compounds.

17. The whole of the facts relative to the osseous texture prove that it is a compound of two principal substances, a gelatinous or glutinous base, and an insoluble salt. The first constitutes its true organic type; it is this which exists at first as membrane, as cartilage, and which gradually becomes filled by the progress of ossification in young animals, with small crystals of phosphate of lime which furnish its areolæ, and there assume the granulated, lamellated, cellular form, which is determined by that of these primitive areolæ, after the manner of a kind of mould. The first dissolves in water, is gradually decomposed, and leaves the bones brittle in proportion as its quantity diminishes. The other being soluble in all the acids which carry it off, reduces the bone in proportion as it

is

is dissolved to its primitive cartilaginous or gelatinous nature. The one gives the primitive form, the pliability, the soft and polished texture. The other produces the solidity, the hardness, the resistance, and the permanent form. The first if it predominates, permits the bones to extend themselves, to form apophyses, sinuosities, and depressions, by the attracting action of the muscles and the compressing action of the arteries &c. The second, when it comes to be predominant, opposes the change of form, renders the bones dry and brittle, frequently adds to their thickness, renders them deformed, enlarges them irregularly, and fills their cavities.

18. But though the general and in some sort common or average nature of the bones is at the present day well known; though their analysis throws some light upon their formation and the alterations of which they are susceptible; yet much still remains to be done, and what lights may we not expect from future labours and researches upon the bones of the fœtus compared with those of the adult and of old men; upon those of the different animals compared with the human bones, especially in the inferior orders of the amphibia and of the fishes, whose organs and functions, so different from those of man must produce such remarkable differences in the nature and composition of their parts. How many interesting facts will be presented to physiologists by a well conducted examination of bones that have

been buried for a longer or ſhorter time in the earth, expoſed to the air or immerſed in the water, and changed more or leſs conſiderably in their intimate nature, either by the ſubſtraction of ſome of their conſtituent materials, or by the addition of ſome foreign matters.

19. A vaſt career is ſtill open to chemiſts, if they chooſe to apply the means which they already poſſeſs to the highly intereſting experiments upon oſſification, and the regeneration of the bones, commenced under other relations by Duhamel, Fongeroux, Haller and Troja; if they compare the progreſs of the formation and the ſolidification of theſe organs in the fœtus and in the young animal, at different periods, with the quantity and the nature of its aliments; if by varying theſe, and adding to them ſubſtances which are known to influence the colour and the conſiſtence of the bones, they follow with all the requiſite attention the relations of both; if they multiply theſe uſeful experiments in animals of different orders, in the frugivorous and carnivorous mammalia, in the aquatic fowls and the birds of the foreſt, in the amphibia, and even in the fiſhes; if by laying bare the bones in ſome points in theſe living animals and inveloping the oſſeous parts with different ſubſtances, or with different elaſtic fluids, they thereby appreciate the influence of theſe contracts and the kind of alteration to which they give riſe; if the external irritation and the deſtruction of the external perioſteum, with the internal

ternal irritation and the diſorganization of the marrow, be obſerved with care, and combined with the other modes of experimenting adopted by Duhamel and Fougeroux.

20. The proſpect enlarges and affords hopes of ſucceſs ſtill much more important than the preceding, when theſe exact analyſes, theſe valuable reſearches ſhall have been extended to diſeaſed bones, ſoftened as it were, fuſed in the Rachitis, the lacteal affections, hardened and ſwelled in exoſtoſes of different kinds, corroded and deſtroyed in different kinds of caries, dry or humid, ſlow or rapid; ſplit, diſtended, inflated in the *ſpina ventoſa*, the necroſis; re-formed, regenerated, doubled in the ſequeſtra, fractures, callus. All theſe alterations ſo well deſcribed and known by the moderns, in which they have found ſubjects of obſervation which had eſcaped the ancient phyſicians, and views of treatment, with motives for prognoſticating the cure which had been intirely neglected before; theſe cannot be really underſtood, nor their cauſes appreciated, their curative treatment reſcued from the mere empiriciſm that has hitherto directed it, unleſs by poſitive experiments, well inſtituted analyſes, for which the preſent ſtate of chemiſtry preſents means ſo new and ſo ſuperior to thoſe which the ſcience formerly poſſeſſed.

Article XIII.

Of the Animal Matters contained in the Osseous Cavity of the Cranium, or proceeding from it.

1. IN the twelve preceding articles, we have spoken of the different liquid and solid matters which are generally diffused throughout the whole body, and which constitute, as it were, its solid elements. In the present article we shall treat of the matters which are found in the cavity of the cranium. We shall not, however, speak of the membranes, the dura mater, the pia mater, and the arachnoid; nor of the sanguineous vessels, as these bodies present nothing different from what has been set forth in general concerning the membranous and vascular texture, in one of the preceding articles. We shall treat of the cerebral matter, of the nervous fluid, of the liquor of the ventricles, and of the pineal concretions: these are in fact the four substances particularly contained in the cranium, and which, presenting an aspect, a structure, or physical properties different from these which occupy other cavities of the body, consequently deserve a particular examination. Two of these matters belong to the animal liquids, another to the soft part, and the last to the solids.

SECTION I.

Of the Cerebral and Nervous Pulp.

2. THE brain, this viſcus ſo regularly organized, and ſo voluminous in man, in whom it exceeds in weight the relative quantity contained in the cranium of any other animal, is furrowed at its ſurface into a multitude of grooves, elevated into protuberances at a number of points, preſenting tortuous inequalities which have been compared to the inteſtinal circumvolutions, forming, at a ſmall depth beneath this unequal and, as it were, carved ſurface, a homogeneous maſs, of a grey colour externally, in its cortical layer, or cineritious ſubſtance, it is of a milk or ivory-white colour in its interior, preſenting in its continuity an admirable ſeries of forms, of colours, of protuberant, rounded, elongated parts, of cords, cavities, and tubercles, conſtant and regular in all individuals. This organ, which the anatomiſts, and eſpecially Soemmering and Vicq-d'-Azyr, have ſo well deſcribed, without however having been able to ſay any thing concerning the uſes of all its very diverſified parts; this anatomical and phyſiological enigma, which no naturaliſts has yet been able to unravel, repreſents a kind of thick paſte, of a more or leſs

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ſolid pulp, divided into the cerebrum properly ſo called, the cerebellum,, and medullary prolongations, which proceeding from theſe two centres, give riſe to the medulla oblongata, to the pairs of nerves, and to the ſpinal marrow. The nerves which proceed from the baſe of this viſcus, and thoſe which paſs from the ſpinal marrow to diffuſe themſelves throughout the whole body, and give it the cauſe of motion and ſenſation, are themſelves real cerebral emanations, covered with membranes borrowed from the membranes of the medulla itſelf, from which they detach themſelves, and relinquiſh them where they enter the parts to which they communicate the powers of motion and ſenſation.

3. The curious form and ſtructure which this viſcus exhibits, its ſize and quantity correſponding with the intellectual faculties of the animal, the ſenſes which are contiguous to it, and, as it were, its neareſt appendages, the internal ſenſation which appriſes every one that the conſciouſneſs of his actions, his deſires, his will, the exerciſe of all the faculties of his mind refer themſelves to the interior of his head; the leſion of the function of the nerves, of motion, of ſenſation, even of thought, the madneſs, the fatuity which conſtantly accompany morbid changes produced around or in the interior of the cerebral texture, of whatever nature they may be; the lethargy, the imbecility, the fatuity, the idiotiſm, which are the conſequences

confequences of preffure applied to thefe organs—all announce that the brain is the feat of the fenfations, the fenforium commune, the grand focus of life, and the general fource of the functions, which are called *animal* or *intellectual.* The anatomy of animals, purfued in all the orders of thefe organized beings, from man down to the teftacea and worms, confirms this general notion, by fhowing the progreffive degradation of the organization, of the mafs, and of the different portions of this vifcus, correfponding with a kind of ftriking precifion with the diminution of fenfibility, of intelligence, of inftinct, and of fenfitive organs in thefe beings.

4. Incomprehenfible to the moft able anatomifts, who have beft underftood and demonftrated its numerous circumvolutions, its moft hidden ftructure, its moft delicate parts, this vifcus prefents no more hold, or rather it affords no more fatisfactory refults to the chemift than to the phyfiologift, who has examined only its ftructure. The one, after the moft perfevering labours, is no lefs aftonifhed than the other, at the fmall degree of relation which he finds between his refult and the properties of this living organ. Few learned men have yet occupied themfelves with the analyfis of the cerebral pulp, or medulla; and, before the moft modern times, they had not even the curiofity to attempt to inveftigate its nature and compofition; there were fcarcely more than a few facts, borrowed

borrowed from the art of cookery, or obferved in the proceffes employed by anatomifts for demonftrating the different parts of the brain, that had afforded a fuperficial notion of its chemical properties. Garman had announced its fingular prefervation in the offeous cranium of buried bodies. Burrhus had compared its texture with an oil, and had even confidered it as approaching to the nature of fpermaceti. Citizen Thouret firft defcribed a feries of experiments upon the nature of the medulla of the brain, in a Memoir publifhed amongft thofe of the Society of Medicine, and reprefented it as a kind of faponaceous fubftance, compofed of an oil and fixed alkali. I publifhed, in March, 1793, in the Annales de Chimie, tom. XVI. an analyfis of the human brain, and of that of feveral of the mammalia, of which I fhall here prefent a notice.

5. The human brain, which I fhall take as the example and type, frefh and cut into flices, placed in a flafk with a tube, immerfed under a bell glafs full of water, at 20 degrees of temperature, give out at firft fome bubbles of carbonic acid, but it afterwards prefented no gas during more than a year; it exhaled a bad fmell without experiencing any real fermentation, or very perceptible alteration in its fubftance, &c.

Expofed to the air, at a temperature exceeding 12 degrees, the brain becomes very fetid, affumes a green colour, putrefies, but neverthelefs

theleſs acquires acidity, and reddens blue paper.

Dried on the water-bath it firſt coagulates, a ſmall quantity of water is ſeparated from it, and it diminiſhes from $\frac{4}{5}$ to $\frac{7}{8}$; it grows leſs, becomes yellow; it kneads and balls under the fingers. When afterwards ſtrongly heated in an earthen crucible, it exhales ammonia, ſoftens, ſwells, becomes brown and black, melts, diffuſes thick and acrid fumes, inflames, remains for a long time ignited after the diminution and ceſſation of its flame; it then affords ſulphureous acids, produced by the combuſtion of the ſmall quantity of ſulphur which it contains, melts in this ſeemingly coally ſtate, acquires a ropy liquidity, becomes fixed into a ſort of blackiſh and brittle bitumen, and affords no trace of alkali in its lixiviated coal. When the dried brain is treated in the retort, we obtain from it water charged with ſeveral ammoniacal ſalts, a conſiderable abundance of oil, concrete carbonate of ammonia, carbonated and ſulphurated hidrogen gas, and carbonic acid. We find ſome traces of phoſphates of lime and of ſoda, but no free in its coal.

6. The cerebral pulp diluted with water, and ſuſpended in it like a thick emulſion, is coagulated by heat, and ſeparates into flakes like milk treated with an acid. The liquor, ſeparated from the flakes, is precipitated by lime-water and by the calcareous ſalts; it becomes coloured as it evaporates; it affords phoſphate

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of ſoda by cryſtallization. All the brains of the mammalia and birds preſent the ſame character of being diluted in water by trituration, and ſeparating from it in coagulated flakes by the action of heat. This viſcus and glairy ſolution froths by agitation, and reſembles a ſtrong ley of ſoap ſo nearly, that it might be miſtaken for it by its appearance. A part of this cerebral matter ſuſpended in the emulſive form, ſwims like a kind of cream at the ſurface of the liquor. Alcohol coagulates and precipitates, in condenſed flakes, the matter of the brain thus diluted and ſuſpended in water. It is alſo to be obſerved, that this liquor, of an emulſive or ſaponaceous appearance, does not alter the vegetable colours; the acids decompoſe and coagulate it. The cerebral pulp, ever after its coction, and the kind of hardneſs of coagulation, which it experiences to dryneſs, when heated on the water-bath, after having ſuffered a portion of this liquid to eſcape, and having aſſumed, in the kind of dryneſs which it acquires, a fawn-colour, whilſt it is reduced to a fourth or fifth of its primitive weight, has not loſt all its attraction for water; it may ſtill be diluted in it by mere trituration, and preſents a yellowiſh emulſive liquor, which indeed is quickly decompoſed, throws down flakes of hardened pulp, and retain only ſome ſoluble ſalts.

7. The brain dried, baked, and even beginning to roaſt, in the manner of thoſe vegetable

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ſubſtances from which oil is obtained by preſſure, being placed betwen two hot plates of iron, and ſubjected to the action of a preſs with a lever a metre in length, and moved by two men, did not yield a ſingle drop of liquid oil. This experiment, indicated by Burrhus, who aſſerted that he had extracted a concreſcible oil, from the dried brain, had no ſucceſs; and there is reaſon to believe, that this author employed brain already altered, either by time, or by the proceſſes to which he had firſt ſubjected it. This property of affording a concrete oil, or rather of having almoſt its whole maſs converted into a concreſcible oil, analogous to ſpermaceti, is however acquired by the cerebral pulp, by means of the gradual putrid decompoſition which it undergoes in buried bodies. This is one of the curious obſervations that were made by Citizen Thouret and myſelf upon the bodies with which the ground of the burying place of the Innocents in Paris, was filled to a great depth. They all preſented in their cranium the maſs of the brain leſſened, contracted, occupying not more than from a tenth to a fifteenth of the volume of this cavity, frequently moving freely within it, of a much firmer conſiſtence than in its natural ſtate, of a blackiſh or dark-brown colour in its interior part. This pulp, thus dried and hardened, preſenting no longer either the external form or the internal appearance of the brain from which it had its origin, was brittle, ſoftened

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under the finger, was diffufible in water, exhaling a faint difagreeable fmell, and prefented all the characters of an ammoniacal foap. It afforded by the acids which decompofed it a thick, fatty, oily, fufible precipitate, which became fixed into cryftalline laminæ by cooling, was foluble in alcohol, and in fhort, poffeffed many properties analogous to fpermaceti. But it is very evident that this oily matter does not exift ready formed in the brain, and that it is the product of a feptic alteration, which announces indeed, in the cerebral pulp, a greater difpofition than in many other animal fubftances to acquire this form and this character of an adipocirous oil.

8. The cerebral pulp being diluted in water, and mixed with fulphuric acid, coagulates into flakes, which may eafily be feparated from it and obtained upon the filtre. The filtrated liquor contains a fmall quantity of animal oil, which burns, is decompofed, and precipitates carbon by the progrefs of the evaporation. We find in it lime, foda, ammonia, united either in part or wholly with the fulphuric acid that has been added, and free phofphoric acid. The coagulated matter does not prefent the oily characters, but thofe of a concrete albumen.

Weak nitric acid decompofes the brain in the fame manner; the concentrated nitric acid immediately coagulates it, difengaging from it azotic gas, produces confiderable effervefcence, and foam, almoft pro-

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duces inflammation. It leaves to a coally, ſwelled and voluminous matter, and exhales a mixture of nitrous gas, carbonic acid gas, and ammoniacal gas. We find phoſphate of lime, oxalate of lime, and oxalate of ſoda in the ley, and in the aſhes of the coal obtained by this experiment.

Muriatic acid poured upon the human brain, diluted in water, ſeparates from it coagulated flakes which ſwim at the ſurface. The liquor cleared by repoſe, and ſeparated from the coagulum by the filtre, being evaporated by a gentle heat, affords tranſparent pellicles which blacken at the end of the operation: we extract from it by the ſame evaporation, and by abſorbing the exceſs of acid by means of ammonia, ſoda, lime, and phoſporic acid, united partly with each other, and partly with the muriatic acid. The coagulated and dried part is about a tenth or twelfth of the original weight of the brain employed; it preſents all the properties of a concrete albuminous matter.

9. The leys of cauſtic fixed alkalis act powerfully upon the cerebral pulp. This action takes place even in the cold: much caloric and ammonia are diſengaged. This laſt effect, which is obſerved even upon freſh brains, preſents itſelf even with ſuch as are already acrid. The medullary pulp becomes greyiſh, and ſometimes of a light roſe colour. When its ſolution is effected by heat, it comports itſelf like a ſoap. This effect reſembles what has been ſtated elſewhere

where concerning the action of the alkalis upon the animal ſubſtances in general, and it depends upon the alteration which the albuminous cerebral ſubſtance experiences at the very moment of the mixture. The opoſite effects of oils heated with the ſubſtance of the brain is ſufficiently known, as this is an experiment which is conſtantly made in boiling and frying this alimentary ſubſtance in oil; one part, nearly the half, diſſolves and gives to the fixed oil a pretty ſtrong conſiſtence: the other dries, contracts, coagulates, bakes, and aſſumes a denſity, an agreeable taſte, with an inſolubility which it did not poſſeſs before.

10. The action of alcohol upon the cerebral pulp, deprived of a great part of its water by deſiccation, is one of the moſt ſingular phenomena which this ſubſtance has preſented to me. When treated four times in ſucceſſion with twice its weight of well rectified alcohol, and by an ebullition of a quarter of an hour each time, in a mattraſs with a long neck provided with a grooved ſtopper, in order that as little alcohol as poſſible may be loſt, the three firſt portions of alcohol decanted boiling, depoſited by cooling brilliant laminæ of a yellowiſh white colour, leſs in quantity each time; the fourth ſcarcely depoſited any thing. The cerebral matter loſt $\frac{5}{8}$ of its weight; and I obtained in all, by the ſpontaneous depoſition and by the total evaporation of the alcohol, $\frac{2}{8}$ and a half of needled cryſtals, of large plates,

or

or of granulated or more condenſed matter. There were, as is evident, $\frac{2}{8}$ and a half loſt in water volatilized with the alcohol. This cryſtallized ſubſtance, of a fatty appearance, became agglutinated into a paſte under the finger; it did not melt in the heat of boiling water, but was merely ſoftened. At a higher temperature, it ſuddenly acquired a blackiſh-yellow colour, and exhaled during its fuſion an empyreumatic and ammoniacal odour. It had therefore no real analogy with ſpermaceti, which melts between 32 and 35 degrees, nor with the fat matter of putrefied bodies, which melts at 28 degrees; it ſeems more to reſemble the fat lamellated cryſtals contained in the biliary calculi, which do not ſoften even at 90 degrees of Reaumur's ſcale. This latter ſubſtance does not become either ammoniacal or empyreumatic at this temperature, like the cryſtalline cerebral oil extracted by alcohol.

11. I muſt here obſerve that the portion of this concrete oil, ſeparated from the alcohol which had diſſolved it by evaporation in the ſun, and which had formed itſelf into a granulated pellicle at its ſurface, in conſequence of the particles being rapidly attracted towards thoſe placed in the centre; preſented ſome properties modified in a different manner from thoſe of the portion of the ſame oil depoſited ſpontaneouſly by the cooling of this alcoholic ſolution. It was a little more abundant than the firſt, of a deeper yellow colour, having a very marked ſmell

Section II.

Of the Nervous Fluid.

13. MOST phyfiologifts admit a very light and very moveable fluid, almoft to be compared with the electric or magnetic fluid, which they believe to flow by the impulfe of the will or of any irritation from within the brain, or the cerebellum, or the medulla oblongata, or the fpinal marrow into the nerves; and the ufe of which they confider to be that of conveying the caufe of motion and fenfation. They cannot, however, give any other proofs of its exiftence than the diminution or ceffation of the nervous action in confequence of ligatures applied to the nerves, or of a compreffion which they imagine muft impede or ftop the motion of this fluid. There is no cavity in the nervous chords; we fee in them no other matter than the medulla which occupies their centre, and a mucous liquor which moiftens their membranes. This difficulty vanifhes with thofe who reprefent this fluid as poffeffing a tenuity fuperior to that which is known in any of the vifible animal fluids: it not only efcapes our fenfes, but the imagination itfelf can fcarcely comprehend its velocity.

14. In

14. In admitting this fluid, it muft be fuppofed to have either two oppofite kinds of motion, which is difficult to be conceived in the fame nerves; or elfe two kinds of nervous channels, the one carrying the fenfitive fluid from the organs of the fenfes affected from without into the brain, the feat of the *fenforium commune*, the others conveying it from the brain into the vifcera and the mufcles, in order to carry into them the principle of life and of independent motion, which is fupported in the former, and the command of the will which folicits and provokes it in the latter. It muft moreover be admitted, that this nervous fluid can follow only a fingle courfe, whether in one or in the other of thefe channels, for it cannot return againft itfelf, and confequently, it would appear to be diffipated after its effect has been produced, which accords with its extreme tenuity and the great velocity of its motion. It is undoubtedly on account of thefe difficulties that fome phyfiologifts have denied the exiftence of that fluid which others had called *animal fpirits*, and that they have thought they could explain the functions which were attributed to it, either by a rapid impulfe communicated to an uninterrupted globular texture in the brain and the nerves, or by a vibration excited on the filaments of thofe organs. In fact, thefe two hypothefes are attended with no lefs difficulty than that of the exiftence of a fluid, fince they fuppofe a tenfion, a rigidity, or folidity in

the nervous fibres, which the moſt ſimple obſervation leads us to reject.

15. No experiment, nor fact, can throw the ſmalleſt light upon or give the moſt ſimple notion of the nature of the nervous fluid. It is intirely and perfectly unknown to thoſe who admit it, and who have no doubt of its exiſtence. It has been ſuppoſed to be the ſame with the electric fluid, but the nerves exhibit no ſign of electricity; and though ſome experiments ſeem to prove, that after death they are very good electric conductors, none can lead us even to ſuſpect its exiſtence in the nervous ſyſtem, and its paſſage, as well as its accumulation in the different regions of that ſyſtem. To admit, ſince the diſcovery of Galvani reſpecting metallic irritation, a particular fluid different from the preceding, of which the brain ſhould be the reſervoir, and the nerves its different ducts, would be the fabrication of an hypotheſis deſtined to be inceſſantly overturned by new reſearches. Some have ſuppoſed the nervous fluid to be a gas, more eſpecially oxigen gas; but it would require hollow tubes to conduct it, and nothing of this kind is known either in the brain or in the nerves. It muſt therefore be admitted, that we are abſolutely ignorant of what the nervous fluid may be, as well as of the general mode in which the action of the brain and of the nerves conſiſts.

SECTION

SECTION III.

Of the Fluid of the Ventricles of the Brain.

16. IN the ventricles of the brain, as well as between its membranes and its furface, is found a flightly vifcous fluid, which inceffantly exudes from the arterial extremities, which lubricates and foftens the furfaces between which it exifts, and prevents them from forming adhefions with each other, as is alfo found in all the other cavities between the furfaces of the membranes of the body. Authors improperly call it a vapour. It is inceffantly fucked up by the abforbent veffels, or by the veins. It fometimes accumulates and forms dropfies of the head of different kinds. A fimilar liquid exifts in the middle cavity of the fpinal marrow and between its membranes. This humour does not appear to differ from that which lubricates all the membranous cavities of the human body in general, and of which I have already fpoken. It is a mucofo-gelatinous liquid, more or lefs albuminous, and containing fome faline matters. It is the fame matter which filtrates between the fibrous fafciculi of the cerebral medula, and renders them foft and pulpy.

SECTION IV.

Of the Pineal Concretions.

17. EVERY anatomiſt knows that the pineal gland, the uſes of which are abſolutely unknown, frequently contains in the interior of its pulp, two or three ſmall hard concretions, which are found in it by cruſhing this glandular body between the fingers. Theſe concretions are ſo common, that very few brains are opened in the anatomical theatres in which they are not met with. They are generally ſo ſmall and ſo light, that it is neceſſary to collect ſeveral of them together, in order to be able to examine them. About twenty of them are required to form a gramme. They are irregularly rounded bodies, with aſperities and points at their ſurface, never ſmooth and poliſhed. I have found them to be compoſed of phoſphate of lime united to about one third of their weight of gelatinous matter. As the calculi of the pineal gland are ſo frequent in the human brain, and as they do not appear to produce diſeaſes, they may be conſidered almoſt in the light of natural concretions, or depoſitions, the formation of which, in this ſingle region of the brain, is indeed a ſingular phenomenon, the cauſe of which deſerves to be inveſtigated by anatomiſts.

Article XIV.

Of the Liquids peculiar to the Eye; of the aqueous, vitreous and cryſtalline Humours, and of the Tears.

1. THOUGH I here indicate in particular, as humours of the eye, thoſe only which are known by the name of aqueous, vitreous, and cryſtalline humours, and tears; this admirable organ contains alſo ſeveral other liquid, ſoft, or ſolid ſubſtances, which would deſerve a particular examination, but with which chemiſtry has not yet been occupied. We are entirely ignorant of the nature of the black *pigmentum;* of the choroid, which appears to be carbon; of the ſoft and tranſparent pulp of the retina, the principal ſeat of viſion, and which is certainly not a ſimple albuminous humour, as its aſpect ſeems to announce; of thoſe hard and thin membranes which form the ſhell of the eye; of that brilliant, pearly, gold-coloured lining which inveſts the internal ſurface of the globe of the eye. We have ſcarcely yet occupied ourſelves, or to ſpeak more properly, we have as yet only ſome preliminary, and as it were proviſionary notions of the vitreous, aqueous, and cryſtalline humours, according to the experiments of Petit and Chrouet, who have publiſhed a Diſſertation

tation upon the humours of the eye. The tears are a little better known.

2. The aqueous humour is contained, in the proportion of from a quarter to a third of a gramme, in the two chambers of the eye, the anterior and the poſterior, between the ſurface of the tranſparent cornea and the cryſtalline humour. It is ſeparated by the arteries of the ciliary proceſs and of the iris; it runs out in part by the pores of the cornea, where it is taken up again by the abſorbent veſſels. Its renovation is ſo prompt, that after it has been evacuated in the operation of the cataract by the aperture made in the cornea, it is renewed and diſtends this membrane within twenty-four or thirty-ſix hours. Halloran has ſeen a gramme and one-third of it flow in twelve minutes from a wound in the eye. Bertrandi thought it was lighter than water, in the proportion of 975 to 1000; but there is reaſon to believe that this is an error. It is perfectly tranſparent, has a ſlightly ſaline taſte, and a very great liquidity. It evaporates intirely and without reſidue. The acids and alcohol do not effect its coagulation; the nitric acid, the nitro-muriatic acid, and eſpecially the oxigenated muriatic acid, have the property of rendering it a little turbid. Though little charged with animal matter, it putrefies and exhales a bad ſmell. We find in it alſo ſome traces of alkaline phoſphates, of ſoda, and of muriate of ſoda. Its uſe is to diſtend the cornea and ſupport its rounded form, and

and retain the cryſtalline and the vitreous humours in their poſition. It ſometimes accumulates to ſuch a degree as to puſh the cornea before it in a hideous manner in the hydrophthalmia: it is ſeemingly gelatinous in the tortoiſe and in ſome fiſhes.

3. Scarcely any thing has yet been ſaid concerning the nature or the compoſition of the vitreous humour; it derives its name from its tranſparency and its aſpect, which reſembles melted glaſs. Incloſed in membranes, or very cloſe membranous cells, it occupies all the bottom of the globe of the eye from the poſterior ſurface of the cryſtalline to the ſurface of the retina; it is ſlightly reddiſh in the fœtus, and is never known to become opaque in old age. The exact degree of its denſity is not known; but it is known to be ſuperior to that of the aqueous humour, and inferior to that of the cornea. Wintringham found it relatively to water, as 10024 to 10000. Its quantity is conſiderable, for, according to Petit, who has given both in the Memoirs of the Academy of Sciences, of Paris, for 1728, and in particular letters, an exact deſcription of the parts and of the humours of the eye, it conſtitutes of itſelf more than two-thirds of the weight. Some of its chemical properties have been indicated by Petit, Chrouet, Mauchart, and Zinn. It does not coagulate in boiling water; it is evaporated intirely by the fire; it contains but very little ſalt and earth; the powerful acids and the fixed alkalis

alkalis render it a little turbid. It becomes glutinous, thick, even concrete, and more or less opaque in some diseases, especially in the glaucoma. Duhamel saw it once sensibly reddened in an animal to which he administered madder.

Boerhaave observed already long ago, that a wound made into the vitreous substance suffered the humour of this substance to run out only in a successive, gradual manner, drop by drop, whence he concluded that this humour was contained in numerous cells communicating with each other, narrower in the interior and wider at the outer part of this body, to which its apparent viscidity is owing; for when we suspend a vitreous humour by a thread over a vessel, in proportion as the humour runs out, the small divisions of the membrane contract, disappear by approaching each other, and the liquid collected is as thin and as fluid as water.

4. The crystalline lens, seated in the anterior fossa of the vitreous substance, and inclosed in its particular capsule, is an almost solid or semi-concrete body, like a very thick jelly, of a lenticular form, the form, the curvature, and the internal structure of which have been carefully investigated and described. It has a diameter of about four lines in man, and the average amount of its weight is a quarter of a gramme. It is heavier than water, and sinks to the bottom of this liquid. Very soft in the fœtus, it grows hard in old persons, and by the progress

progreſs of age it gradually paſſes from a perfectly colourleſs and tranſparent ſtate into a yellowiſh colour, like topaz or amber, with a ſlight obſcurity. It is very eaſy to be cut or divided; preſſure bruiſes and extends it, and ſeparates the greater part of its particles.

It has long been known that it is ſuſceptible of becoming opaque, cartilaginous, oſſeous, and even of an almoſt ſtony hardneſs. The example of fried fiſhes ſhows us that the cryſtalline lens becomes concrete by the action of heat; that it is rendered white and friable, like a kind of ſoft plaſter; that it ſeparates into concentric plates, which are eaſily divided into a hundred; and that theſe plates are formedof fibres intertwiſted, or rolled up in ſpiral windings.

Chrouet, in his hiſtory of the humours of the eye, aſſures us that the cryſtalline affords oil and ammoniacal ſpirit in great abundance by the action of fire. Twenty-four grammes of this body diſtilled, afforded him two grammes and a quarter of inſipid water, eight grammes of ammoniacal water, a third of a gramme of concrete carbonate of ammonia, a little leſs than three grammes of very fetid oil, and eight grammes of coal, the incineration of which left a gramme and a half of aſhes without fixed ſalt or alkali.

The cryſtalline becomes opaque by coction in boiling water, by the action of the acids, and by alcohol. It ſeems to be formed of a thick, albuminous

albuminous and concrescible matter with a portion of gelatin. No exact analysis has yet been made of it.

5. The tears are secreted by a conglomerate gland, situated in a depression at the external and superior angle of the orbit, and they are discharged by six or seven open ducts in the conjunction over the margin of the upper eyelid, whence they flow along the eye towards the puncta lacrymalia. They have not been the object of a connected series of researches. They had been represented as a rather saline aqueous liquor, affording scarcely any residuum by evaporation; and Pierre Petit, in his curious treatise on the tears, being intirely occupied with their origin and their relations with the passions, had scarcely said any thing concerning their nature. The illustrious Haller complained of this want of facts in his great physiological work; he contented himself with quoting some rare examples of saline crystals which they had exhibited to Bruckman, of those of an austere acid taste, which Schaper had observed in an ophthalmia of the blood which frequently is mixed with them, of the sweet quality which had been found in them in some diseases. Several fortunate opportunities for procuring them having presented themselves to Citizen Vauquelin and myself, in 1791, we made them the particular object of our researches; and we have published upon the Analysis of this humour, in the Annales

Annales de Chemie, for Auguſt of the ſame year, a Memoir of which I am now about to preſent the reſults.

6. We procured tears in ſufficient abundance to be able to make them the ſubject of our experiments, either from perſons ſubject to weeping, who conſented to collect them in ſmall glaſs veſſels, or by cauſing them to flow in unuſual abundance, by means of mechanical irritation applied to the noſtrils, or by the effect of cold, which increaſes their diſcharge in ſome individuals. This humour is as clear as water, without ſmell, of a ſaline taſte, and of a weight little ſuperior to that of diſtilled water. It turns the paper tinged with mallows or violets green, without this colour being diſſipated in the air; a proof that it proceeds from the action of a fixed alkali. When heated, it preſents at its ſurface many permanent bubbles, like a mucous liquor; evaporated to dryneſs, it leaves at moſt 0,04 of a dry and yellowiſh reſiduum of an acrid taſte. In cloſe veſſels it affords much water, ſome traces of oil and of ammonia, and a very ſaline coal. The incineration of the product of the ſpontaneous evaporation exhibited to us muriate of ſoda, carbonate of ſoda, very little phoſphate of ſoda and phoſphate of lime.

7. Tears expoſed to hot and dry air, in a flat veſſel, become thick pretty quickly; they become viſcid and ſtringy, without loſing their tranſparency; aſſuming a yellowiſh and ſometimes

times a green colour. They afford cubic cryſtals, which alcohol diſſolves without attacking the mucous and thick part; theſe cryſtals turn paper ſtained with mallows green, and announce an exceſs of alkali. Water which diſſolves immediately, in every proportion, and dilutes the lacrymal humour in its natural ſtate, does not operate in the ſame manner upon this humour when thickened and become ſtringy by expoſure to the air. It remains ſuſpended in the water like a glairy matter, or elſe diſſolves very ſlowly; for the water froths by agitation, after having remained a long time upon this matter. This is an inſtance in which the contact of the air deprives an animal matter of its ſolubility in water.

The alkaline ſolutions, which have no ſenſible action upon the pure tears, quickly diſſolve tears that have been thickened by expoſure to the air, and reſtore them to their original fluidity and tranſparency.

Lime-water, the ſolutions of barites and of ſtrontian, produce no effect upon the tears at the moment of their diſcharge; but when they have been for ſome time expoſed to the air, they render theſe liquors turbid, and afford very ſenſible precipitates of earthy carbonates. This phenomenon proceeds from the circumſtance that the tears contain a ſmall quantity of pure ſoda, which attracting the atmoſpherical carbonic acid, and paſſing gradually by the contact of the air into the ſtate of alkaline carbonate, be-

comes

comes thus susceptible of being decomposed by the solutions of the three earths, whose attraction for carbonic acid is stronger than that of the soda. Alcohol forms very sensible white flakes in the tears, and retains the most of their salts in solution.

8. No acid has any action upon the tears at the moment of their discharge, when they have not yet experienced any alteration. No other change takes place in them, than the saturation of the soda which they contain: so that the smallest quantity of acid is sufficient to prevent their turning the mallows-paper green. The residuum of their spontaneous evaporation comports itself differently with the acids. A drop of concentrated sulphuric acid thrown upon this residuum produces a very sensible effervescence, accompanied with a white vapour; muriatic acid and carbonic acid are disengaged at the same time, which announces the decomposition of the muriate of soda contained in this fluid, and of the carbonate of soda which is formed in it by exposure to the air. The muriate and acetous acids, on the contrary, produce only a slight effervescence with this spontaneous residuum of the tears, because they decompose only the carbonate of soda, and disengage only the carbonic acid.

9. The oxigenated muriatic acid is one of the re-agents that have given us the most light respecting the nature of the tears. We already know

know from a fact, which cannot escape our observation in active laboratories, that the contact of the oxigenated muriatic gas thickens the lacrymal humours to such a degree, as to render the motion of the eye-lids upon the ball of the eye difficult and painful. When liquid oxigenated muriatic acid is poured upon tears at the moment when they have been discharged from the eye, a slight coagulation takes place in this liquid; flakes are precipitated, at first white, which are quickly turned yellow by a larger proportion of acid. In proportion as they are formed, the oxigenated muriatic acid loses its harsh smell; whence we see that it yields its oxigen to the animal matter. It cannot be doubted, that what here takes place rapidly, is effected in a gradual manner upon the tears by the contact of the air; that in both cases the fixation of the atmospheric oxigen is alone to be considered as the cause of the thickening and the formation of a white and seemingly puriform matter, which takes place in the nasal sac, when the tears remain in it, obstructed by any impediment. A slight compression, to the application of which persons subject to obstructions of this sac are incited by an itching sensation, causes this thick yellowish matter to issue out from the puncta lacrymalia, in small cylinders or elongated drops, more or less solid, moulded by the branches of the lacrymal syphons. We must add indeed to this action of the atmospheric oxigen, the evaporation of

the water as a caufe of this thickening; for we were convinced by a fubject afflicted with an obftruction of the nafal fac, that he could extract four times as much humour from this diftended fac by preffing it out every hour, than by foliciting its difcharge every four hours. The fame infpiffation, proceeding from the abforption of the air by the tears and the evaporation of their water, gives rife to thofe fmall clots of thick, yellowifh, and concrete humour, which are formed during fleep, round the lacrymal caruncles.

10. It refults from this analyfis that the tears are formed of a large quantity of water, which holds in its folution an animal mucilage, not albuminous, becaufe the fimple acids do not coagulate it, but of a gelatinous nature, and feveral faline fubftances, muriate of foda, pure foda, phofphate of foda, and phofphate of lime. The two laft are lefs perceptible than the two firft. One of the characters that moft eminently diftinguifh this animal matter, is the property which it poffeffes of rapidly abforbing oxigen, and of forming thick, concrete, infoluble flakes. Though it contains the muriate and the phofphate of foda in but fmall quantity, the firft is neverthelefs fufficient to give this humour a faline tafte, and enable it to depofit fome faline cryftals on the outfide of its ducts, as fome rare obfervations have fhown.

The phofphate of lime, of which we have found only fome flight indications in the tears, may,

may, it appears, increafe in its proportion under certain circumftances, and feparate in the folid form: it is this which gives rife to the calculous concretions which are fometimes formed in the lacrymal glands, and are even depofited in fmall feparate grains round this gland. I have twice had occafion to analyfe this concretion, and have found its folid bafe to be calcareous phofphate.

Article XV.

Of the Nafal Mucus

1. THE name of *nafal mucus*, is given to a liquid which is fecreted in the cavities of the nofe, and is difcharged outwardly, either by the noftrils in the form of drops, or in that of maffes more or lefs thick and vifcid, or by the fauces, when it defcends by the pofterior part of the nafal cavities in which cafe it is thrown out by hawking and fpitting. This liquid is feparated from the blood by the arteries, with which the whole fchneiderian membrane is provided, and appears to be formed in particular glandular crypts, which we find abundantly diffeminated in the noftrils; it is collected alfo from all the frontal finufes, from thofe of the ethmoid, of the fphenoid and of the fuperior maxillary bones, upon the membraneous fides

of

of which we fee no glanduliform crypts. It is alfo mixed with the lacrymal juice, which defcends by the channel which paffes through the os unguis, and dilutes the thickened nafal mucus.

2. We muft particularly confider both the abundance and the characters of this liquid in the catarrh, improperly called catarrh of the brain, in which the nafal mucus is feparated in larger quantity, and remains a longer time in its ducts. It is efpecially under this circumftance that Citizen Vauquelin and myfelf have examined it, as we then procured it with great facility. We have alfo availed ourfelves of the confiderable difcharge of mucus which is produced by the contact of the oxigenated muriatic acid gas, in order to obtain a fufficient quantity of it for the experiments adapted for making us well acquainted with its nature. It has feveral times happened to Citizen Vauquelin, who is very fenfible to the action of the oxigenated muriatic acid gas, that he has collected by its effect fixty-four grammes of this liquid in lefs than an hour. By means of thefe circumftances we have been enabled to determine its nature in a confiderably exact manner. It is known that this liquid is very abundant in children, that it is a little heavier than water, and adheres to moft bodies, even the moft polifhed.

3. The nafal mucus is at firft liquid, clear and limpid, a little vifcid and adhefive, without

ſmell, of a ſaline and acrid taſte, which irritates the moſt delicate part of the ſkin: it is then really the pituita vitrea of the ancients. When expoſed to the air and to the fire, it comports itſelf in the ſame manner as the tears, from which it differs only by the abundance of its reſiduum which is thicker, and frequently more coloured. It affords cryſtals of muriate of ſoda, of ſoda in the ſtate of carbonate and of phoſphates of lime and of ſoda; the laſt are much more abundant than the others. It turns paper ſtained with mallow-flowers green, by its ſalts; we alſo find in it an animal matter which is not albuminous, but quickly becomes thick and concrete by the oxigen of the air and of the oxigenated muriatic acid; it then acquires opacity, and a yellow or greeniſh colour, ſwells conſiderably, and becomes filled with bubbles by the action of fire, leaving but little reſiduum upon the ignited coals. This animal mucilage, which is more abundant than in the tears, appears to be of the ſame nature in both.

4. This liquid, being always expoſed to the air which continually paſſes through the noſtrils, is conſtantly thicker, more viſcid and more adheſive than the tears; and the carbonate of ſoda which it contains, whilſt the latter contain only ſoda, announces that the air depoſits in it a part of the carbonic acid which it contains, eſpecially as it is expired out of the lungs. Conſequently, it then renders the ſolutions of barites, of

ſtrontian,

ſtrontian, and of lime, very ſenſibly turbid. In the noſtrils, the heat of the plant, eſpecially in catarrhs, and the current of air which inceſſantly acts upon it, contribute alſo to thicken it. The mucilage of the naſal humour, when it becomes thick in the air, frequently aſſumes in it the form of ſmall, dry brilliant, and as it were, micaceous plates. If it has dried in very thin layers, it nearly reſembles thoſe brilliant and light marks which ſnails leave behind them upon the ſubſtances over which they crawl. The naſal mucus experiences no real putrefaction in the air; we ſhould almoſt be induced to ſay that it was unalterable and imputreſcible, when we ſee it remain without contracting any bad ſmell, even in the midſt of water, and at a conſiderably elevated temperature. However, this property of preſervation does not extend ſo far as to communicate itſelf to other bodies that are immerſed in it.

5. Water does not diſſolve the mucus of the noſe. It is known that this matter remains viſcid in that fluid, and that it cannot be diluted water without much difficulty, even by agitation.. Hot water and ebullition do not render this ſingular mixture more miſcible or more ſoluble. In boiling water, it appears at firſt to form one body with the water; nevertheleſs we ſee it ſeparate and fall to the bottom of this liquid by cooling. It is probable that this inſolubility is owing to the fixation of the oxigen. Neither has it the property of ren-

dering oils miscible with water, nor of effecting their suspension by trituration, as a vegetable mucilage does. It is on this account that when we wash, or even boil this thick humour in water, the salts which it contains are dissolved and separated, without affecting the mucilage which constitutes its base.

6. The acids thicken the nasal mucus when they are concentrated and employed in small proportions; but when we add a larger quantity, they re-dissolve and give it different shades of colour. The sulphuric acid tinges it purple, and renders it very liquid, forming however some flakes in it which sink to the bottom. The nitric acid, when rather strong dissolves it of a yellow colour. The muriatic acid is that which effects its solution the most easily and the most completely of all, giving it a violet colour. The alkaline or earthy salts do not cause it to undergo any alteration, nor do they dissolve it.

7. The mucus of the nostrils being especially distinguished from all the other animal liquids by the viscid mucilage which it contains in considerable abundance, it is evidently from the presence of this principle that we ought to seek its uses and the function which it performs in the animal economy. Besides the kind of evacuation, sometimes very abundant, which it procures, and the proportion of the evacuated matter compared with that of the other excretory organs, which it carries out of the body, this

liquid

liquid maintains the ſoftneſs of the membranous ſides of the naſal cavities and prevents that dryneſs which the air paſſing in continual ſtreams through theſe cavities tends to produce in them. It moderates the too great ſenſibility of the nervous papillæ which are ſpread out upon the olfactory membrane; it ſtops and fixes the odorous bodies, it blunts their too great activity; it purifies the air that is reſpired, by taking from it the pulverulent particles which it carries along with it, and which would be more hurtful in the lungs. Being always contained in a hot humid, and arid place, three circumſtances which would ſo eminently promote putrefaction, provident nature has given it a property which oppoſes the ſepticity which would have expoſed man and the animals to a multitude of dangerous vitiations and maladies.

8. It is known that the mucus of the noſtrils is capable of changing its nature and aſſuming various properties in the naſal affections. It thickens, becomes yellow, orange-coloured, or greeniſh, frequently tinges linen with a very lively green caſt by drying upon it; it ſometimes produces the ſenſation of the preſence of copper; and ſometimes it exhales a nauſeous or fetid ſmell. In ſome affections it becomes ſo acrid that it ſeems to corrode the membrane of the noſtrils, and produces excorrations round their orifices as well as upon the upper lip. Laſtly, it is ſometimes liquid like water, at others ropy like oil; in ſeveral caſes thick,

viſcid,

viſcid, and always tranſparent like jelly ; in other circumſtances, ſemi-concrete and white, yellow or green, like a purulent humour. None of theſe changes have yet been chemically examined, and hardly even has the attention which they deſerve been beſtowed upon them.

9. Citizen Vauquelin and myſelf have deſcribed with much care the effect which the oxigenated muriatic acid gas produces upon the naſal mucus and upon the membranes which it covers and from which it filtrates. At the very moment when this gas penetrates into the noſtrils, it produces in them a ſenſation of contraction and of uneaſineſs, of which ſneezing is the conſequence ; a conſiderable diſcharge of clear liquid is excited. The contraction and the rigidity of the membranes of the noſe and of the throat remain for a long time : after the ceſſation or diminution of the firſt diſcharge, follows an uneaſineſs and ſtuffing of the noſe, and the ſenſes of ſmell and taſte are loſt. An humour, thick, and even dry like parchment, is felt in the noſe and in the fauces: an acrid heat propagates itſelf into the breaſt and produces a febrile commotion : a conſiderably violent head-ache, and confuſion of intellect accompany this ſtate. At laſt white or yellow concrete maſſes are diſcharged by the noſtrils or the mouth, the diſcharge of which laſts ſeveral hours, procures relief, and the malady gradually ceaſes till the equilibrium is intirely re-eſtabliſhed. It

cannot be doubted that this artificial disease has a great analogy with the natural catarrh, and that in the production of that disease the atmospheric oxigen exerts an action similar (excepting that its intensity is less) to that of the oxigenated muriatic acid. In the sudden sharp frosts which are perceived by a harsh rough sensation, this principle of the atmosphere acts very quickly upon the nasal mucus; it thickens it by depriving it of water and becoming itself fixed; it irritates the surface of the schneiderian membrane; it evaporates, in the compound ratio of its motion and its density, a large quantity of water. This explanation of a natural fact, to which we have been conducted by a phenomenon created by art, shows what may be hoped from the researches of modern chemistry, and how important it is to pursue them without intermission.

ARTICLE XVI.

Of the Mucous Humour of the Mouth, of the Humour of the Tonfils, of the Saliva, of the Salivary Calculus, and of the Tartar of the Teeth.

1. THE cavity of the mouth, from the margins of the lips to beyond the velum pendulum of the palate, and as far as the upper part of the pharynx, is conftantly moiftened by feveral liquids which have their fource in different glandular and fecretory organs, whofe seat, form, ftructure, excretory ducts and functions have much occupied anatomifts and phyfiologifts. Very numerous mucous crypts and granulated pellicles occupy the whole furface of the tongue, and efpecially of the infralingual cavity, of the buccal and palatine membrane or of the glandular expanfion of Morgagni, of the alveolar arches, and pour into this cavity an humour fomewhat lefs thick and mucous than that of the noftrils, which maintains on all the fides of the mouth a continual foftnefs and lubricity, adapted to facilitate their motion, to enable the alimentary bole to flide down, and to prevent that thirft which drynefs of thefe parts, from whatever caufe it may arife, conftantly produces. This kind of mucous and lubricating humour have

have never been examined in particular, nor could it, either becauſe it is not ſufficiently abundant to be collected ſeparately, or becauſe it is always mixed with the ſalivary humour and the humour of the tonſils which inceſſantly flow into the mouth. For the reſt, it does not appear to be in any reſpect different from the humour which is ſecreted in all the cavities in order to lubricate them, and of which we have already treated.

2. The tonſils, organs very ſingular in their form and their fungous ſtructure, placed on both ſides of the throat before the paſſage of the alimentary bole, and between two membranous columns which ſupport the velum palati, inceſſantly diſcharge into the poſterior fauces, by the numerous crypts and pores with which their whole ſurface is covered, a ſomewhat thick and glairy humour, which is frequently ſeen about them when they are viewed with attention, and which we feel detach themſelves like ſmall gluey maſſes by the rapid motion which is communicated to the air in the action of hawking. It is believed that this humour, the quantity of which muſt be pretty conſiderable from the ſize of the organs which furniſh it, is of the ſame nature with that of the crypts, and that of the glands of the mouth. No particular examination however has been made of it, and we ſtill judge of it only by the analogy of its place of ſtructure and its uſes.

3. The

3. The saliva, properly so called, separated from the blood in the parotids, the submaxillary and sublingual glands, poured into the mouth by the ducts of Stenon from the first, of Warthon from the second, and of Rivinus from the third, has been, if not analyzed with much attention, at least sufficiently examined by Vieussens, Pott, Nuck, Barchusen, Verheyen, Boerhaave, and Haller, to be better known than the preceding liquids. Haller, in his great physiological work, has collected all that physiologists had observed before him. I have added some facts to those which had been indicated by the authors abovementioned. Citizen Michel de Tennetar has described some phenomena which this humour presents in acting upon the metallic substances. Citizen Lachenaye has given a sufficiently detailed analysis of the saliva of the horse; but none of these chemists has announced more experiments, or a more conclusive series of inquiries, than M. Siebold, who published, in 1797, at Jena, a sufficiently detailed dissertation in quarto, upon the salivary system, considered in a physiological and pathological point of view. I shall borrow from these different authors, as well as from my own observations, what I am about to say concerning this humour.

4. The saliva is a slightly viscous liquid, strongly characterized by its frothy state, its insipid and partly saline taste, its want of smell, its

sweetish

ſweetiſh odour, and its white colour mixed with a blueiſh caſt. Its weight is to that of water, according to Haller, as 1960 to 1875, and according to Mr. Siebold, as 1080 to 1000. The proportion of its conſiſtence, or of the coheſion of its molecules to that of water, as 30 to 10. Mr. Siebold, in order to define this conſiſtence in a more perſpicuous manner, ſays that it reſembles a mixture of one part of gum and forty parts of water. It is neither acid nor alkaline: it does not change the natural ſtate of any vegetable colour. Brugnatelli aſſerts, that he has found it impregnated with a large quantity of oxalic acid in an emaciated venereal patient, who appeared to him to loſe, by this evacuation, the nutritive and ſaccharine part of his aliment. Its quantity varies greatly. Nuck eſtimates it between 256 and 384 grammes in twenty-four hours. In exceſſive ſalivations, its diſcharge has been to the amount of two or three kilogrammes daily: Turner eſtimates its whole quantity, diſcharged during an entire mercurial courſe, at 60 kilogrammes or 120 pounds. Some authors have aſſerted that the ſaliva carried mercury along with it; but it has never been practicable to extract any from it in the experiments made in the laboratory of the Ecole de Medicine of Paris.

5. The ſaliva, heated or evaporated, leaves but very little reſidue; it ſwells conſiderably, and ſoon dries into ſmall white or yellowiſh, ſaline and acrid plates. When it is evaporated

to

to a third of its quantity, and afterwards ſuffered to cool and repoſe, it affords cryſtals eaſily diſtinguiſhable as muriate of ſoda, by their cubical form, their ſaline taſte, the muriatic acid vapour which the ſulphuric acid diſengages from them, and the curdled precipitate which they form in the nitrate of mercury. Gently evaporated to dryneſs, the ſaliva leaves a reſiduum like the glutinous matter of flour, which ſwells and inflames upon the coals, exhaling a ſmell of burned horn or hair. A ſmell of Pruſſic acid is alſo perceived. When the ſaliva is ſubjected to diſtillation in a glaſs retort, we ſee a froth ariſe upon it, which occupies a large ſpace; it affords all the products of the animal matters, and leaves a coal in which I have found, beſides the muriate of ſoda, phoſphates of ſoda and lime in conſiderable abundance. Pruſſic acid is alſo very perceptible amongſt the products. The proportion of ammonia formed is not larger than in the diſtillation of the other animal matters.

6. When expoſed to the air, the ſaliva abſorbs a conſiderable quantity, and froths much by agitation; at the end of ſome hours, according to the obſervation of Mr. Siebold, it preſents a light pellicle, exhibiting the priſmatic colours, and of a fatty appearance at the ſurface; it ſoon becomes turbid, and depoſits flakes; it exhales a very lively and very pure ammoniacal odour. Macbride believed that there eſcaped from it a large quantity of fixed air:

air: this he particularly concluded from the large volume and the frothy ſtate which it aſſumes in vacuo: it is well known that it is ordinary air which is diſengaged in this experiment. The ſaliva putrefies and becomes very fetid after the ammonia which has formed in it has been diſengaged. This humour, however, has been conſidered, according to the experiments of Pringle, as eminently antiſeptic, and it has been pretended that it checks the putrefaction of meat immerſed in it. Indeed, a greater number of authors have on the contrary ranked it amongſt the moſt powerful ferments, and have particularly deſignated it as promoting the vinous fermentation of the farinaceous ſubſtances; they have even thus explained how the ſavage nations of America and Africa prepare intoxicating liquors with maſticated roots and ſeeds, which they afterwards expoſe to fermentation. This property deſerves ſtill to be better aſcertained by accurate experiments.

7. The ſaliva has long been known to corrode or oxidate iron and copper pretty quickly. It was alſo cuſtomary, in the laboratories of pharmacy, to ſpit in the mortars in which the mercurial ointment was prepared, and it was known that this proceſs accelerated the extinction or the black oxidation of the mercury. Citizen Michel du Tennetar, profeſſor of chemiſtry at Metz, diſcovered, about twelve years ago, that when leaf-gold and leaf-ſilver were triturated

in

in ſaliva, the oxidation of both theſe metals, which are ſo difficult to be burned, was effected. It appears that it is ſtill more eaſy to oxide mercury by itſelf in this animal liquor, from a method which has been long practiſed by the Engliſh ſailors, and which conſiſts, according to what I have heard from able phyſicians of that nation, in kneading ſome globules of mercury in the hollow of the hand with the aid of ſaliva, and immediately taking the mercury thus extinguiſhed. By rubbing mercury in ſmall globules adhering to the fingers greaſed, upon the inſide of the cheeks, and as in the method of Clarke, venereal ſymptoms are cured: all theſe phenomena depend upon the ſame cauſe.

8. The ſaliva mixes but imperfectly, and does not completely diſſolve in water; it ſwims at its ſurface, and remains well ſeparated from it. This effect has been attributed to its viſcidity and ſluggiſhneſs; to which we muſt add the little ſoluble nature of the animal mucilage contained in this liquor. Ebullition of the water coagulates ſome flakes in it, and retains the ſaline matters, which it ſeparates from it. The ſtrong acids, in ſmall doſes, thicken the ſaliva, as we perceive in the mouth when we hold an acid liquor in it; in larger doſes they diſſolve it. The fixed alkalies and the earths immediately diſengage ammonia from it. Lime-water, and the ſolution of barites form a precipitate of phoſphate of lime in it; the oxalic acid

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ſhows the preſence of lime by the precipitate which it produces, though it be very ſlight. The metallic ſolutions, eſpecially the nitrates of lead, of mercury, and of ſilver, render the ſaliva very turbid, and produce an abundant precipitate in it: it was eſpecially by theſe means that I found the phoſphates that exiſt in this animal liquid; for theſe metallic precipitates afford very ſenſible traces of muriatic acid and phoſphoric acid both at the ſame time.

9. From all the facts here enunciated it follows that in man, the ſaliva is formed of a quantity of water, which is eſtimated at $\frac{4}{5}$ or $\frac{4}{7}$ of a highly aërated animal mucilage, frothy, almoſt inſoluble or very little ſoluble in water, or of a ſmall proportion of albumen and of ſaline matters, which are muriate and phoſphate of ſoda, ammonia and lime. This manner of conceiving the compoſition of this liquid, beſides that it is the reſult of the experiments hitherto made upon its nature, explains alſo all the phenomena which the ſaliva preſents, its ſemi-coagulation by fire, by the acids, and by alcohol; its difficult ſolution in water, the light flakes which it affords in many caſes, its ſluggiſh viſcidity, its frothy property, and its precipitation by a multitude of bodies. The ſaliva muſt be conſidered as a condenſed ſolution of this viſcid mucilage, which very readily detains the air into which it is immerſed, to carry it into the alimentary bile, and into the ſtomach. The ſalts which it con-

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tains may vary in their proportions, and actually do vary, according to a multitude of circumstances.

10. It frequently happens that there are formed in the strainers of the saliva, and deposited in the excretory ducts of the salivary glands, some kinds of concretions or calculi, which have been improperly called stones. They have been particularly observed in the Warthonian duct much more frequently than in the Stenonian, or that of Rivinus. Haller, after having quoted a multitude of examples from authors, inquires what may be the cause that favours this formation in the first class of these ducts rather than in the two others. We are not sufficiently acquainted with the structure of the different salivary glands to be able to pronounce upon the cause of this singular prerogative of the Warthonian duct. Scherer, in a dissertation intituled *De calculo in ductu salivali*, has described with great care the maladies which this species of concretion produces, and all the circumstances which accompany it. Hippocrates was already acquainted with the stone under the tongue. The tumor called *ranula*, and *anginas*, have been known to be the consequences of this kind of concretion. Many facts have also proved that it is speedily formed. I have examined one of these salivary calculi given me by Citizen Sabbatier, and I found it to be composed of phosphate of lime and of a kind of animal mucilage. Its source is

is therefore manifeftly in the faliva, which, like all the white and more or lefs vifcid humours, contains phofphate of lime, the proportion of which is fometimes augmented by caufes that are hitherto unknown or undetermined. It appears that this augmentation depends, in feveral circumftances, upon a general caufe, and that it takes place in all the humours at the fame time, undoubtedly becaufe the ducts which naturally evacuated its fuperabundance are then too much conftricted. In fuch cafe, fimilar concretions are formed in many places, and fome are depofited even in the fubftance of the membranes.

11. Thofe very frequent incruftations which furround the bafe of the teeth, and are known by the name of tartar, which loofen and repel them, deftroy the gums, and fometimes become fo confiderable that they feparate and difplace the teeth themfelves in fome individuals who take no care of their mouths, are alfo of the fame nature. The faliva, and the other juices of the mouth which inceffantly bathe thefe bones, and remain between the margins of the gums and the teeth, gradually depofit upon them, by a real cryftallization, particles of this earthy falt; and it is not to the refidue of the aliments, as is commonly believed, that this pretended *tartar of the teeth* is to be attributed. When we examine with a good magnifying glafs the tartariform concretion which encircles thefe bones towards their

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baſe, and which ſometimes extends as far as their alveolae to the ſides of which it attaches itſelf, we find it compoſed of ſmall grains united together and brilliant in ſome points. We perceive in it, by the microſcope, a great number of pores or ſmall polyhedral cavities which reſemble the cells of polypuſes in their form and arrangement. Magellan, the philoſopher who undoubtedly ſaw microſcopic animalcul in it, thought that this concretion was a ſort of nidus of *polypuſes* formed by theſe animals. But it is more natural to believe, that this cryſtalline depoſition of the humours of the fauces, ſimilar to the concretions ſo generally diffuſed and ſo common in the animal economy, receives at its ſurface and in its pores ſome particles of alimentary reſidue, charged, like every ſoft, humid, and warm organic matter, with microſcopic animalcul. The nature of this depoſition upon the teeth is really phoſphate of lime, mixed with a portion of mucous and glairy ſubſtance: accordingly, the acids diſſolve it, as has long been known, by the employment of theſe ſubſtances adapted for cleaning the teeth, upon which indeed the acids act in a dangerous manner if care be not taken to confine their operation merely to the layer of tartar which ſurrounds and covers them.

Article XVII.

Of the Cerumen of the Ears.

1. THE cerumen of the ears, ſo called on account of the conſiſtence of ſoft wax which it commonly has, attracted the attention of the ancient phyſicians much more than of thoſe of the preſent age. The ancient ſchools, as Bourdeu has obſerved, taught that the gall-bladder was purged of this humour of the ears. Hippocrates aſſiduouſly occupied himſelf with the conſideration of it in diſeaſes, and compared its production with the flow of the bile: the moderns have intirely neglected this kind of obſervations; and at the preſent day the analogy, which ſubſiſts between this humour and that ſecreted by the liver, ſeems forgotten. The cerumen, however, poſſeſſes properties ſo remarkable, ſo different from thoſe of moſt of the other animal liquids, that I have thought I ought to aſſign to it a particular article. What does not appear ſtriking to every one at preſent may appear ſo hereafter. This aſſertion is particularly applicable to the matter which forms the ſubject of the preſent article, and of which but very little has been ſaid by any author, even amongſt thoſe who have particularly occupied themſelves with the organ of hearing,

Caſſebohm, Valſalva, Duverney, Schroeder, Le Cat, &c. Haller, who according to the order which he had adopted, exhibits by his vaſt erudition all that the anatomiſts and phyſiologiſts had diſcovered before him, has ſcarcely devoted five or fix lines to the examination of the diſtinctive properties of the cerumenous humour.

2. This humour is prepared in a particular glandular apparatus diſcovered by Stenon, ſeen by Drelincourt, well deſcribed by Valſalva, Duverney, and Haller. It conſiſts of ſmall round and oval glands, of a browniſh yellow colour, of a very firm conſiſtence, diſſeminated under the ſkin, and placed, either in the excavations of the oſſeous auditory paſſage, or in the cartilagineous portion of this paſſage, eſpecially towards its anterior part. Each of theſe ſmall glands has a very ſhort cylindrical duct, which perforates the epidermis, and opens into the auditory paſſage by an orifice viſible to the naked eye. There runs out from it a ſmall drop of a yellow humour, at firſt a little viſcid like an oil, which quickly thickens in the warm cavity of the ear by the contact of the air, and is converted into a kind of unguentaceous matter, of a deep yellow or orange colour, or even reddiſh, of a very bitter taſte, which inflames when it is heated, as Boerhaave had eſpecially indicated. Pechlin has compared the cerumen to caſtoreum. It had eſpecially been remarked that this humour might, by remaining

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for a long time in the auditory paſſage, thicken in ſuch a manner as to form a ſolid cylinder, capable of obſtructing the paſſage like a real ſtopper, and prevent ſounds from arriving within it; that this thickening, which ſome authors have obſerved as far as concrete and plaſter-like ſtate, was a frequent cauſe of deafneſs, and that it was cured by injecting ſoap-water.

5. Theſe facts comprehend, even in the moſt learned and extenſive works, the whole hiſtory of the cerumen of the ears. Bordeu, who in many parts of the art, wiſhed to revive the notions of the ancient phyſicians, and eſpecially thoſe of the Coan ſchool, contented himſelf with prognoſticating, after having noticed the attention which this ſchool paid to the cerumen, that ſome practitioner might meet with a particular caſe adapted to explain the pretenſion of one of the ancients with reſpect to this ſubject. Nearly thirty years have elapſed during which this ſuggeſtion of an enlightened man has called in vain for obſervations. Whilſt I indulge the hope that phyſicians may beſtow upon the ſubject the attention which it deſerves, I ſhall exhibit ſome ideas reſpecting the chemical properties of this humour, which is difficult to be procured in the abundance requiſite for ſubjecting it to extenſive reſearches. I muſt ſay, that of all the phyſicians whom I have acquainted with the importance which I attach to the examination of this humour, my colleague

league Hallé was the perſon who was moſt ſtruck with it, and that he ſucceeded, by his enlightened zeal for the progreſs of our art, in furniſhing Citizen Vauquelin and myſelf with a ſufficient quantity of cerumen to enable us to begin an exact analyſis of it.

4. The cerumen collected during ſeveral ſucceſſive months by a healthy individual, with the aid of an ivory ear-ſpoon, and kept in a piece of paper, impregnates the texture of the paper like a fat oil rendering it tranſparent, and preventing water from penetrating it. It is eaſy to be united and kneaded into a ſingle maſs; I have formed an almoſt ſolid ball of it, which was of an orange-yellow colour, nearly without ſmell, of the conſiſtence of ſoft wax, and of a bitter, diſagreeable taſte. When placed upon an ignited coal, the cerumen inſtantaneouſly melts; it quickly ſwells and exhales a thick fume, the ſmell of which is ammoniacal, and of a ſenſibly aromatic fetidity; it does not differ much from that of burned horn or hair; it emits very little flame at the end of this operation. It leaves a coal, which has loſt the pretty conſiderable volume which this matter had at firſt aſſumed, and which is too little abundant to be analyſed: this coal is difficult to be incinerated. We had too ſmall a quantity of cerumen to be able to diſtil it, eſpecially after to the little light which this experiment promiſes.

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5. The cerumen triturated with water, in a mortar, dilutes pretty well and diffolves in part. It affords a kind of emulfive liquor, of a yellowifh white colour, in which we fee fmall drops of oil collect at the furface. This is manifeftly the effect of a mucilage holding for fome time an oil in fufpenfion. The matter thus diluted is fufceptible of the putrid decompofition, though the intire cerumen keeps for whole years without any fign of putrefaction; it is, next to the folid or offeous parts, the leaft alterable of the animal matters. Alcohol takes up but very little from it, and is only flightly coloured, even when it is boiled for fome time upon the cerumen: when this coloured alcohol is filtrated and left to cool, a portion of the matter which it had diffolved is feparated fo that the liquid becomes turbid and flightly milky. According to the comparifon of this action of water and of alcohol, the cerumen appeared to us to be an intimate mixture of an animal mucous fubftance with an oily or fatty matter, rendered concrete by the abforption of atmofpheric oxigen. This laft matter renders it fimilar to the bile, to which the ancients had already found it to be analogous.

6. Thus much I, for my own part, was able to afcertain refpecting the cerumen, from the fmall quantity which I had collected from myfelf. Since thefe firft experiments, Citizen Vauquelin, who had undertaken to examine the cerumen with which our colleague, Citizen Hallé,

Hallé, had furniſhed us, and who having a much larger quantity of it, was able to ſubject it to a more regular ſeries of experiments, gave me reports of them, of which I ſhall here exhibit a ſketch, as it is adapted to extend the notions which I have already given, and to give them ſtill greater preciſion.

The maſs which he had to examine formed a ball, ſome centimetres in diameter, and nearly ſix grammes in weight. This matter is pitchy, of a bitter taſte, of a deep orange colour: put upon a piece of paper and ſlightly heated, it melts, penetrates, and ſpots this texture, rendering it tranſparent, as oil does. It has a very particular, ſlightly aromatic, and ſomewhat acrid ſmell, eſpecially when it is heated and rubbed between the hands.

7. Placed upon an ignited coal, the cerumen ſoftens, and exhales a white fume, which has the ſmell of burned fat; it ſoon melts, ſwells, becomes coloured, and emits an ammoniacal and empyreumatic ſmell. After this action of the fire, there remains a voluminous and rather light coal. Diluted with water, the cerumen forms a kind of emulſion of a yellowiſh white colour, which quickly putrefies and becomes very fetid. Though water does not diſſolve it, it however takes ſomething from it; for, in putrefying, it depoſits whitiſh and mucilaginous flakes. Treated with alcohol, with the aſſiſtance of heat, it communicates to it a ſaffron-yellow colour, and by cooling, ſome white flakes are

 depoſited

deposited. Sulphuric ether also dissolves part of the cerumen; and though it deposits nothing by cooling, it acquires a slight colour by remaining some instants in contact with it, either in the heat or in the cold.

8. Two grammes of cerumen treated with hot alcohol lost 1,25 grammes, and afterwards weighed only 0,75 of a gramme. The portion not dissolved, when dried in the air, was transparent, brittle, less coloured, less fusible by the fire, and exhaled, while it burned more ammonia than oily vapour; the coloured alcohol afforded by evaporation a residuum of a pretty dark colour, considerably bitter, of a consistence and smell resembling those of turpentine, fusible without swelling, volatilizing into a white vapour of a fatty smell, and without leaving any perceptible coal: it had all the characters of a fixed oil.

Two grammes of the same cerumen, treated with sulphuric ether, with the application of a little heat, lost 1,25 grammes, and weighed now only 0,95. The liquor was less coloured than that of the alcohol; evaporated by a mild fire, it left a matter of a pale-yellow colour, of a tenacious consistence like turpentine, of a smell analogous to that of this resin, and less bitter than that which had been obtained by the alcohol. The 0,95 grammes not dissolved by the ether, resembled the residuum left by the alcohol, and exhaled much ammonia upon ignited coals. There is, therefore, a striking resemblance

blance between the action of alcohol and that of ether upon the cerumen: both take from it a matter of an oily nature, more ſoluble in the firſt than in the ſecond of theſe liquids, and leave an inſoluble animal ſubſtance.

9. The kind of fatty oil ſeparated from the cerumen by the alcoholic liquids, is fuſible, and diffues upon the coals a pungent adipoſe ſmell; a little coloured, and it is ſuſceptible of diſſolving in the fixed and volatile oils, but with difficulty in cold alcohol; though very completely if we employ a large quantity of this liquid. The leys of fixed alkalies unite with it by mere trituration, and form with it a kind of ſoap, which does not, indeed, aſſume either the taſte or the conſiſtence of common ſoap.

As to the matter inſoluble both in alcohol and in ether, ſince it becomes dry and brittle in the air, ſince it ſoftens and even partially diſſolves in water, which afterwards putrefies; ſince it is capable of exhaling empyreumatic ammoniacal fumes whilſt it ſwells upon the coals, and of diſſolving, though imperfectly in the alkalies, theſe characters manifeſtly belong to albumen; and what confirms this notion is, that when it is burned in a crucible of platina, it leaves a light coal of an acrid and alkaline taſte, manifeſtly containing ſoda and phoſphate of lime.

10. Beſides theſe two ſubſtances, the baſes of the cerumen of the ears, it manifeſtly contains a diſtinct colouring matter, though it has not

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yet been obtained feparate, on account of the too fmall quantity which we have hitherto had of this animal product. It appears that this colouring matter is the caufe of its bitternefs, and that it is the principle of the cerumen which varies the moft, fince in fact the moft ftriking differences which are remarked in it relate to its colouration and its bitternefs.

Citizen Vauquelin has given the following refult of this mafs. The cerumen of the ears is a compound of three fubftances: 1ft. a fatty oil, more analogous to that which is contained in the bile, than to any other adipofe animal matter; 2d. an albuminous animal mucilage; 3d. a colouring matter which feems to refemble that which forms part of the bile, by its bitternefs and its adhefion with the fatty matter.

11. The ufes afcribed to the cerumen are, to foften and lubricate the fides of the meatus auditorius, to deter infects from entering into this paffage, by its bitternefs, to foften and even deaden the fonorous vibrations of the air, and thus to moderate the force of found. There is reafon to believe, from the oily nature of the cerumen, and its bitternefs, that it ought to be ranked in the clafs of excretions, and that it evacuates a particular acrid matter. If, as the ancients remarked, its quantity increafes in fome circumftances of difeafes, and if its proportion anfwers to that of fome other evacuations, the obfervations which Bordeu called upon the phyficians to make, may fome day afford

afford more light respecting the uses of this humour. Haller does not forget to remark, according to Derham, that birds have no cerumen, and that it is found only in those animals whose meatus auditorius is more or less elongated. In fact, it is abundant in some of the mammalia; and it would be of great utility to the art to examine it with care in these animals, in order to ascertain its properties and the relations or differences which subsist between it and that of man.

Article XVIII.

Of the Tracheal and Bronchial Humour; of the Pulmonary Gas, and of the calculous Concretions of the Lungs.

1. BY referring to this article, all the animal matters which belong to the chest in particular, and which are situated within the cavity of the thorax, we find a much greater number of these matters than I have inserted in this title. In fact, we must rank in this class the tracheal humours, the humour of the bronchial glands, the arterial and the venous blood, the air inspired, the air expired, or the pulmonary gas, the pulmonary transpiration, the humour of the pericardium, that of the pleura, the concretions of the lungs, the parenchymatous

tous texture of this viſcus, and the texture of the heart. But amongſt theſe twelve ſubſtances, there are many which are already known, and which have already been treated of in the articles concerning the matters generally diffuſed throughout the whole body. In fact, I have elſewhere ſhown the difference between the pulmonary, arterial and venous blood, and the blood of the other regions. The air inſpired is that of the atmoſphere, which has been examined in detail in the ſecond ſection; the pulmonary tranſpiration has been compared, in one of the preceding articles, with the cutaneous perſpiration of the whole body; the humour of the pericardium and that of the pleura preſent no difference from that of the other internal membranous ſurface; the parenchymatous texture of the lungs, which has been confounded with the cellular texture, has not yet been particularly examined; that of the heart is only muſcular fibre, more denſe than that of moſt of the muſcles. There are therefore to be examined with more detail, only the tracheal and the bronchial humours, the pulmonary gas, or the air evacuated by expiration, and the calculous concretions. I have not even comprehended, in this general enumeration, the humour of the thymus; becauſe, excepting that it has been compared with milk on account of its whiteneſs, its nature is abſolutely unknown. Not the ſlighteſt experiment has been made upon its compoſition and its properties, though this

this object is very interefting, and deferves all the attention of phyfiologifts.

2. The larynx and the trachea are continually lubricated and moiftened by a humour which extends throughout the whole continuity of the bronchial, and which covers, lubricates, and softens their internal membrane. This humour is a little vifcous and gluey; it is tranfparent, and of fuch a confiftence, that it cannot flow; for, had it this character, it would inceffantly irritate this very delicately fenfible paffage, and excite a perpetual cough. This humour of the trachea appears to be of the fame nature as that which moiftens and lubricates all the other cavities or hollow membranes. It is, however, probable, that this liquid has not the fame faline character as the faliva, the mucous humour of the mouth, &c. It is known that the tracheal humour has neither tafte nor fmell. Hitherto it has not been poffible to make any particular analyfis of it, becaufe it is not eafy to procure a fufficient quantity of it for this analyfis. Anatomifts have attributed the origin and referred the fource of this liquid to mucous glands or crypts, fituated under the internal membrane of thefe air ducts; fometimes it is difcharged in the form of fputa. It cannot be doubted that, being inceffantly in contact with the air which penetrates the bronchial vehicles, this humour thickens, either by the evaporation which it undergoes, or by the action which the atmofperical oxigen gas exercifes

cises upon it. Some physiologists have erroneously attributed to it the blackish blue colour, of certain flaky matters which are coughed up, and which proceed from another source, of which I shall speak in the following number.

3. The tracheal humour is considered as adapted to prevent the dryness of the internal surface of the larynx, of the trachea, and of the bronchia, a dryness which would easily be occasioned by the contact of the air, that continually passes through these cavities. It is also believed, that it defends the membrane of these very sensible passages against the action of different acrid substances and irritating powders, so often disseminated in the air which incessantly traverses them; finally, the use is attributed to it of rendering the voice soft, and preventing the roughness and hardness which the sounds issuing from the lungs would have, if these tubes were dry and destitute of this lubricating mucilage. The air which descends very dry and very cold into the lungs, takes away much of the evaporable or aqueous part of this tracheal humour, and gives it a remarkable character of glutinosity and adhesion to the sides of the trachea; in this case this thickened matter, which can no longer be easily absorbed, is discharged by the cough which its weight and its irritation excite: such is the cause and the nature of catarrhs. The glairy laminæ, or the more or less concrete flakes, are separated only by a violent effort of the

the air which impels them, and then the cough is convulſive or painful; or elſe they are raiſed or ſlowly detached from above the tracheal membrane, by this liquid humour which exudes beneath them, in which caſe they are coughed up with more facility and leſs pain. It is in this manner that confinement to the bed, by retaining the perſpirable matter in its veſſels, and cauſing that of the lungs to be more abundant, operates.

4. I diſtinguiſh by the name of *bronchial humour*, a kind of matter ſeparated by the glands of the ſame name, which is poured into the bronchia by particular ſmall excretory ducts. It is very different from the tracheal humour; it is not viſcid, ropy, nor extenſible like that matter. It is diſcharged in the morning in the form of ſmall, irregular, and moſt frequently roundiſh lumps, of a conſiſtence reſembling a thick jelly, of a blackiſh or blueiſh colour, inſoluble in water, at the ſurface of which they ſwim; its quantity varies in different individuals. Though it has not yet been particularly examined, its ſenſible characters are ſufficient to diſtinguiſh it as a peculiar matter. The glands which furniſh it, and which have not yet perhaps ſufficiently fixed the attention of anatomiſts or phyſicians, have themſelves a ſtructure very diſtinct from all the other glandular organs. They have been erroneouſly confounded with the ſyſtem of lymphatic glands. Their form, their ſize, their texture,

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their colour, even their confiftence, and their difeafes, every circumftance claims the attention of fcientific men to this organ hitherto too little known. We might be induced to fuppofe, when we obferve their blueifh or blackifh grey colour, their confiftence, and that of the humour which they furnifh, that they form a kind of refervoir for the carbonous matter of the blood. Many obfervations, followed up with zeal and fagacity, are required in order to determine the ufes and the functions of this particular glandular fyftem.

5. By calling the elaftic fluid which is difcharged from the lungs by expiration *pulmonary gas*, my intention is to announce that the atmofperic air, after having remained for fome time in the lungs, is difcharged from them in a ftate of alteration which depends upon the nature of this organ itfelf, and which I have already indicated in the hiftory of the blood. This fluid is nearly the fame in quantity as it entered, fince the carbon and the hidrogen, as well as the water ready formed, which are added to it, correfpond very nearly with the proportion of oxigen gas which it yields to the blood. It contains no more than a few hundredths of this oxigen gas; and if it has been refpired two or three times in fucceffion, which cannot be done without much difficulty, it contains none at all: accordingly, it extinguifhes inflamed bodies, and ftupefies animals. We find in it the fame proportion of azotic gas

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as before. Water is one of the materials that are added in the greateſt abundance to this expired gas, ſince nearly half a gramme of it is expired every minute, or 720 grammes in 24 hours. We alſo find in it gaſeous carbonic acid, proved by the precipitate formed by the expired air when received into ſolutions of lime, of ſtrontian and of barites; it is alſo charged with more caloric than it contained when it entered the lungs: and this is the reaſon why it depoſits water in the form of fumes when it paſſes into a cold atmoſphere. Perhaps it may alſo contain a certain portion of carbonated hidrogen; and we may attribute to this ſubſtance, which has not been rendered ſenſible in it by chemical experiments, the dangerous and deadly effects which it produces, and which are different from the aſphyxia; perhaps ſome animal miaſma, ſome contagious virus may eſcape at the ſame time with the air expired. As it has not yet been exhibited by experiment, it is only by conjecture that we may ſuſpect its influence in the production of diſeaſes, and the ſepticity which it introduces into the humours of thoſe who reſpire it. Chemiſtry ought to occupy itſelf without intermiſſion in confirming or overturning theſe ideas, and rank them amongſt thoſe phyſical truths, the proofs of which medicine muſt either confirm, or elſe arrange them in the claſs of hypotheſes; in fact, theſe are adopted in the

the theory of this important art only for want of exact experiments and facts.

6. One of the matters peculiar to the organs contained in the thorax, and which is only the product of a morbid alteration, but more frequent than has hitherto been believed or asserted, is a concretion formed in the lungs, which has been called *pulmonary stones*, or *calculi:* these are small, hard, unequal and rough bodies, of an irregularly spherical form, resembling small pebbles, of a grey or reddish colour, which becomes white when they are dried in the air, and which are discharged by coughing, sometimes even whilst the person is in perfect health, but most frequently in the course of some attacks of asthma, or of the terrible phthisis pulmonalis. Attentive physicians and exact observers frequently meet with them in their practice. Through their care I have had a sufficient quantity of them to be able to examine them: I have found them to be of the same nature with the pineal, lacrymal, and salivary concretions: they are composed of phosphate of lime, and of a small quantity of gelatinous matter. It is not known whether they proceed from the texture of the lungs or bronchia itself, when the patients discharge them; but dissections prove that they are formed in the areolæ even of the parenchyma of the lungs, since in cutting the lungs a great quantity of them are sometimes found, which grate under the scalpel. Here, as in many

cafes already menti oned, this phofphate of lime depofited by its fuperabundance proceeds from the white humours, when the concretion is fmall and infulated: but it may proceed alfo from the blood, efpecially, when, being numerous and diffeminated in the interior of the organs of refpiration, thefe concretions appear to occupy at the fame time the whole texture of the lungs.

Article XIX.

Of Milk and its different, economical, chemical, alimentary, and medicinal Properties.

Section I.

Natural History, or Formation of Milk.

1. MILK, a liquid fo well known, fo ufeful, fo generally employed as food and condiment, is one of the fubftances which have been moft examined by chemifts, as it is one upon which the proceffes of the arts have been extremely varied. Its hiftory muft be one of the moft detailed, as it is one of the moft important matters with which chemiftry can be occupied: accordingly, we fhall divide this article into eight paragraphs, in order to difpofe in a methodical order, adapted for facilitating its ftudy, the facts which will lead us to under-

understand its properties. The first paragraph will contain an account of its formation; the second, that of its chemical properties; the third, the chemical examination of the entire milk, such as nature presents it when it issues out of its reservoirs; in the fourth I shall treat of the whey; in the fifth of the caseous part, or cheese; in the sixth of the butter or its oily matter; the seventh will be assigned to the examination of the principal differences which this liquid presents in the species of animals which furnish it; finally, the eighth will contain the enumeration of the various uses for which different kinds of milk are employed in rude or civilized society. As milk is one of the liquids with which Nature has supplied the first wants of men, it is not to be wondered at that an immense number of observations have been collected respecting its properties, and that its history, when we consider it successively as naturalists, as physicians, as chemists, or as economists, presents very extensive details.

2. This liquid is formed in a particular organ which occupies the anterior part of the chest, in women, and a large part of the abdomen in the female animals. As there are only a small number of species of animals in which this formation takes place, and as these animals are distinguished from all others by the two well marked characters of bringing forth their young living, and of being provided with *mammæ*, they have been called *mammalia*: these are,

under

under other anatomical relations, viviparous quadrupeds and cetacea. The very beautiful form, the diſtinct protuberance, the hemiſpherical and prominent ſurface, the delicate ſkin which the breaſts of women exhibit, and which conſtitute one of the charms of beauty, the amenity and contour of which artiſts repreſent with ſuch graces, are attributes peculiar to the human ſpecies. We do not find them in the females of any other animals: the number of two is alſo given to but very few ſpecies of theſe. In moſt, the number of mammæ amounts to between four and ten. The female elephant, the mare, the gazelle, and in general thoſe animals that have only one or two young have alſo only one or two mammæ, but ſhaped very differently from thoſe of woman. The nipple is ſingle in each mammæ in woman; it is quadruple in the cow.

3. In works of phyſiology and medicine, examples are frequently quoted of milk ready formed, ſwelling the mammæ of ſome male children and animals, and even of ſome adults: the preſence of this liquid in young girls before the age of puberty is ſtill more frequently ſpoken of. Hence it is concluded that there is no neceſſary dependance between this formation of milk and the act of generation; but theſe rare facts, contrary to the accuſtomed order of nature, do not prove the opinion which is attempted to be eſtabliſhed upon this point: for no accurate experiment has proved that this was real milk:

milk: and as for its having a ſweet or inſipid taſte, an humour formed in ſome circumſtances and by ſome cauſes independent of pregnancy, is not real milk. This rare phenomenon has never been deſcribed except in man, and it has not been obſerved in the animals whoſe paſſions and manner of living are not, like ours, contrary to nature, nor force her to deviate from her ordinary courſe.

4. Under the ſkin of the mammæ are maſſes of ſolid and granulated fat, which it covers; and in a cellular texture with large meſhes is incloſed a conglomerate glandular apparatus, covered with a hard and white integument that occupies the middle of this prominent organ. This apparatus is formed of parcels ſeparated by membranous cells, and theſe parcels are themſelves formed of hard, ſolid, entire grains without cavities, compoſed of implicated veſſels. This mammary gland exiſts in males and in infants, but much ſmaller, and not ſurrounded with fat as in females: fifteen or twenty excretory ducts, viſible, elongated, hard, of a diameter ſufficiently conſiderable during the period of lactation, are collected below the areola of the breaſt, and proceed, without confounding themſelves or anaſtomoſing with each other into the nipples, where they open externally; they are inflected into the rugoſities of the papilla or nipple, and elongated or diſtended when the nipple itſelf is elongated by the kind

kind of erection which friction or suction produces in it. A multitude of other thin and long ducts are observed, which open into the adipose texture, which do not belong to the glands, properly so called, and which Haller imagined to pour a fatty humour into the milk.

5. When the uterus has conceived, the mammæ gradually grow larger, their glandular texture tumefies, the orgasm pervades it, the disposition to form milk gradually establishes itself, which is announced by a limpid or turbid serosity discharged by the papilla. After the birth of the infant, the womb having contracted itself again three or four days after delivery, the milk begins to be really formed; the mammæ become distended, swelled, and painful, and the milk discharges itself spontaneously. The suction of the infant greatly accelerates its discharge, and augments its production. There first runs out a very liquid slightly and opaque liquid, which is the colostrum; soon afterwards, this liquid becomes daily thicker, more perfect, white, odorous, savoury, and susceptible of affording a more and more substantial nourishment to the suckling. It continues to flow for whole years, when the suction and the irritation are not interrupted, and the quantity which is formed is sometimes so abundant that a nurse can suckle several infants at the same time.

6. The

6. The formation and, as it is called, the rising of the milk has great relation with the functions of the uterus. It seems at first that a really milky liquid is formed in this viscus; and the lochia, which have in part the same character, flow till the period when the milk is abundantly secreted in the breasts. Physicians believe that this liquid actually passes from the uterus into the breasts, and a great number of facts proves this sympathy between these two organs. They both assume their peculiar activity at the same period: the breasts become prominent as soon as the menstrual discharge appears, or the genital parts develop themselves; the milk begins to be separated when the menstrual discharge disappears in consequence of pregnancy; its suppression causes the mammary glands to become humid: these glands collapse when the menstrual discharge ceases; and these two organs, the womb and the breast, become inactive, and are excited into activity at the same periods. Physicians even avail themselves of this action when, in order to diminish the too great abundance of the menstrual evacuation, they apply a cupping glass to the breast. Discharges by one or the other way succeed, and correspond with each other. This relation is also proved by the sensation which the titillation of the nipples excites in the genital parts; accordingly the ancients admitted the concurrence of the uterus in the formation of milk.

7. Some

7. Some anatomiſts admit the blood only as the ſource of the milk; they believe the mammary arteries to be its ſole origin. The ſmalneſs of theſe ſanguineous ducts has induced others to think that the arteries do not furniſh the only matter of the milk. Haller admitted in it the admixture or the addition of fat by the ducts of which I have ſpoken. It is pretty generally believed that the chyle contributes more abundantly than the blood to the formation of the milk, becauſe its quantity is always proportionate to that of the nouriſhment; becauſe the chyliferous veſſels exhibit to the anatomiſt a liquid analogous to milk; becauſe milk has frequently the ſmell and ſeveral of the characters of the aliments; and laſtly, becauſe nurſes feel the milk flow into their breaſts at the moment when the chyle aſcends into its veſſels. For theſe reaſons phyſicians have believed that theſe two liquids are ſimilar to each other, and have deſcribed the properties and the morbid affections of the different elements of the chyle like thoſe of the milk: but this analogy, when carried too far, may be erroneous, and experience has not yet proved it in a direct manner. I am much more inclined to believe that the intire lymph, the quantity of which is augmented, and its motion accelerated by the chyle at the moment when it aſcends from the inteſtines into its ducts, contributes to the production of the milk, and that while the blood furniſhes the albumino-caſeous part, the fat affords

fords the butyraceous, and the lymph the ſerous.

8. When the milk is well formed, and diſtends its reſervoirs, frequently the lactiferous or galactophorous tubes, being opened and dilated, diſcharge it ſpontaneouſly: a kind of orgaſm pervades theſe tubes, erects them, dilates them, afterwards contracts them, and gives them that motion, that action which frequently cauſes the milk to iſſue out in more or leſs rapid jets. That ſuction, or the art or mode of which nature has given to the infant from the neceſſity of nouriſhing himſelf with it, ſingularly favours its diſcharge. The vacuum formed round the nipple, with the aid of a ſucking inſtrument, or by means of the neck of a heated bottle applied to it, and the preſſure of the air which applies itſelf with advantage to the hemiſphere of the mammæ, ſolicits this diſcharge with ſuch energy, that we ſee it ſpout out in white streams, of which frequently ſix or eight are very evidently perceived in the females of animals; the action of preſſing the udder from above downwards as far as the extremity of the teat, in milking, or the art of milking, cauſes the milk to flow with facility and celerity. The animals that have had their young taken from them readily ſubmit to this extraction, which is attended with a pleaſurable ſenſation to them. Nature has connected with this excretion a pleaſurable ſenſation which doubles, that of being a mother,

ther, and which attaches, by the gentle bond of gratitude and tenderneſs, the infant who acknowledges no other mother than her by whom he is nouriſhed.

9. The influence which the aliments have upon the formation of the milk, likewiſe merits all the attention of the phyſician. It is known that well-fed animals afford milk of good quality in abundance. Nurſes diſtinguiſh foods by the property which they poſſeſs of increaſing or diminiſhing the proportion of this liquid. The acrid ſmell of garlic, of the alliaceous and of the cruciferous vegetables, paſſes into the milk; the perfume of flowers, the aromatic odour of ſaffron and of thyme, the ſugar of the roots and fruits, the nectar of the petals, give it an agreeable aromatic ſmell and a pleaſant taſte. The red juice of the opuntia, the reddiſh juice of madder, the blue of indigo, vary the colour of this nutritive liquid with the animals into whoſe food theſe colouring matters have been introduced; the bitterneſs of wormwood, the acrimony of the milk-thiſtle, the aſtriction of the aſtringent plants, the purgative property of the Gratiola, are recognized in the milk; different medicinal properties are given to it, according to the different kinds of nouriſhment which are preſented to animals. The milk of a nurſe who has taken a purgative, produces gripes and evacutions in her ſuckling. Wine, beer, the different vinous liquors, give it a diſtinguiſhable property;

property; even poisons, and several diseases, are transmitted in this way; and the milk participates of whatever has been introduced into the stomach of the woman who affords it.

10. Even the passions with which a nurse is agitated, modify both the abundance and the properties of the milk that is secreted in her breasts; anger has been known to derange the system of the infant, and to give it convulsive motions. Chagrin, ill humour, bad news, fear, depression of the spirits, vitiate the sources of the milk, and sometimes produce a sudden collapsion of the breasts. Bad treatment to nurses, manifestly alters their milk: accordingly great care is taken of the female animals destined to furnish milk for the table, not only in the cleanliness and nature of their food, but also by kindness, caresses and attentions of every kind. Several physicians have even carried this influence of the passions upon the milk so far, that they have pretended the milk itself influenced the character and the passions of the young individuals that are nourished by it: thus it has been pretended that infants who have been suckled by choleric and passionate, mild and benevolent, lively and salacious, or stupid and phlegmatic women, acquire the same moral dispositions. But there is reason to believe that this opinion is carried too far, that it is rather from the example of the effects of these different passions that the infants gradually model themselves, and that they are only

imitators

imitators of their motions instead of being physically changed in their sensorium.

Section II.

Of the Physical Properties of Milk.

11. THE quantity of the milk is varied in woman and in the animals by a multitude of circumstances. Abundance of drink in general, induces an abundance of the mammary liquid; soft, highly nourishing and easily digestible aliments produce the same effect. The farinaceous aliments boiled in water, when the stomach digests them well, increase its quantity, and nurses are well acquainted with this kind of influence. It is difficult to fix the limits, or indicate the average terms of this production: it appears however in general that the milk most frequently constitutes a third or a very little more of the weight of the aliments. There have been nurses however, who, besides the milk which they afforded in abundance to their infants, yielded still spontaneously from one to nearly two kilogrammes of this liquid in the day; in the female animals with which this quantity is much more considerable, it is sufficiently known to vary according to the seasons, the places which they inhabit, the pasturages in which they are placed, the nature of

of the fodder which is given them in their ſtalls, their age, and the time more or leſs remote from the period when they have brought forth young.

12. The ſpecific gravity of milk is in general more conſiderable than that of water; Haller ſays that it is to the latter as 277 to 261, or 1043, 1000. It varies, according to him, and the different authors whoſe obſervations he has collected in the following proportions, 1026, 1029, 1035, 1000.

Citizen Briſſon, in his treatiſe upon the ſpecific gravity of bodies, gives the following table of that of the different milks, water being ſuppoſed 10,000.

Womans' milk	- -	10,203
Cows' milk	- -	10,324
Goats' milk	- -	10,341
Mares' milk	- -	10,346
Aſſes' milk	- -	10,355
Ewes' milk	- -	10,409

13. Milk is in general of an opaque white colour, which however inclines towards yellow in woman, towards blue in the cow, and varies in the ſame female according to the proportion of its principles, and conſequently, according to a multitude of circumſtances. However its opacity and its whiteneſs are conſtant, on which account it has been compared to an emulſion, and the latter has been called *milk* of almonds.

Its

Its consistence is that of an oily and aqueous liquid at the same time; when it is very strong and very good, it is a little thick, a drop remains upon the nail without running down, and extends itself upon it slowly: it is in this manner that physicians judge of the milk of nurses; a certain degree of fluidity is nevertheless preferable to a too strong consistence.

14. The taste of milk is bland, agreeable and in general almost saccharine; it has however many modifications in the different species of animals; it has something unctuous and fatty which distinguishes it, which manifestly depends upon its oily nature. Milk has a particular smell, which is pretty generally agreeable; this is one of the properties in which it is most susceptible of variation, according to the nourishment. That which is peculiar to it is however inherent in its intimate nature, and independent of the perfume or the bad smell proceeding from the aliments; it subsists only as long as it is warm; it is most perceptible at the moment when it has been discharged from the mammæ; it is scarcely to be perceived at all when it has entirely cooled; it is renewed by exposure to heat; it is dissipated by ebulition. It is very perceptible and recognizable in clean dairies, at the moment when the warm new milk is deposited in them. The milks of different animals have a particular and well-marked character in their odour.

15. According

15. According to the obſervations of Citizens Deyeux and Parmentier, the milk furniſhed by a cow at different periods, in the ſpace of twenty-four hours, preſents great differences, eſpecially if the milkings are multiplied at irregular diſtances of time. The changes of the atmoſphere, for the animals fed by paſture, are the principal cauſes of theſe differences. The moſt ſingular remark which they have made relates to the diverſity of the milk of a ſingle milking, according to the manner in which this milking is divided, and the udder evacuated at different times. The product of one milking performed with care and received ſucceſſively into four veſſels, affords really four ſpecies of milk: the firſt is the moſt ſerous: the ſecond product is leſs ſo; the third ſtill leſs, and the fourth contains a very large quantity of cream. The dairy women have long been acquainted with this phenomenon, and they avail themſelves of it, by keeping apart the laſt product of the milking, in order to ſell it, under the name of cream, to thoſe who prefer the ſweet, unctuous, thick and fat milk which goes by this name.

16. The times at which the milk is examined preſent variations according to the different lengths of time that have elapſed ſince parturition and the firſt formation of the milk. The moſt ſtriking of theſe differences obſerved in the milk is that which characterizes it in what is called the *coloſtrum*, which is firſt formed immediately after parturition. The coloſtrum

is a fluid of a deep yellow colour, thick, viſcid and ropy, frequently carrying with it ſtreaks of blood, affording much yellow cream; and this a fourth more than the real cream of a deep yellow very ſolid butter, with a liquid leſs white and opaque than the ordinary milk, not coagulable, like the latter, by means of rennet, but viſcid and ropy, little ſaccharine. The coloſtrum changes much; from the ſecond day it loſes ſomewhat of its yellow colour and of the abundance of its cream. In four days, it paſſes into the ſtate of ordinary milk, and it is not till this period that the milk-women begin to vend it in our towns. Reckoning from this fifth day, the milk of the cow becomes conſtantly more and more perfect, acquires a better conſiſtence till the third month when it is the moſt perfect.

Section III.

Chemical Examination of the entire Milk.

17. I HAVE already obſerved that the milk has been the object of much labour and reſearch. Boyle has made it one of the ſubjects of his experiments. Boerhaave firſt treated in a ſufficiently detailed manner. Hoffman alſo made it the ſubject of many experiments. Macquer has deſcribed with much clearneſs and preciſion the proceſſes of its analyſis, and he was acquainted

quainted with its principal properties. Spelman occupied himſelf with its fermentiſcible property ; Rouelle the younger with the mucoſo-ſaccharine matter and the ſalts which it contains. Scheele diſcovered the ſachlactric acid, and ſhowed that the milk afforded in ſome caſes acetous acid, and that the ſpecies of acid into which it is ſpontaneouſly converted has particular and characteriſtic properties. I have given, in 1790, ſeveral new obſervations on the different materials of milk. Finally, Citizen Deyeux and Parmentier have made a great number of reſearches upon the milk of the cow, taken under many different circumſtances, upon the economical properties of this animal liquor and of its products, and upon the changes or modifications of which it is ſuſceptible. Their very extenſive enquiry concerning all theſe objects conſtitutes at preſent an entire work, which preſents the moſt complete hiſtory of this animal liquor. I have here mentioned only ſome outlines of this chemical notice and ſome of the principal authors of its analyſis. We might alſo add the numerous facts deſcribed by Verheyen, Barchuſen, Verduc, Doorſchodt, Egeling, Young, Gouraigne, Acoramboin, Geymuller, Cartheuſer and Gmelin, who have either in phyſiological works or in monographic treatiſes, given more or leſs valuable details concerning the milk of different animals. Haller has laboriouſly collected from theſe numerous writers the facts which he has

employed for his hiſtory of milk; and as the mode of proceeding of theſe authors was not uniform, thoſe multiplied quotations are more capable of embarraſſing than enlightening the reader.

18. Milk expoſed to a moderate fire dilates and ſwells conſiderably: this property is known in the domeſtic uſes of milk; it has been obſerved that it boils at the 199th. degree of Fahrenheit, that alcohol boils at 181, and water only at 212 of the ſame thermometer. There is formed at its ſurface a pellicle which gradually thickens, wrinkles, dries and grows yellow in drying. This is caſeous matter which ſeparates and becomes ſolid; when it is removed, and when we continue to evaporate the milk, there is formed a ſecond pellicle, and ſo on ſucceſſively. It is obſerved that theſe pellicles are thinner and more tranſparent in proportion as the evaporation advances; they ſeparate in this manner till there remains only a ſerous and almoſt tranſparent liquid in the veſſel. In order to obtain and perfectly ſeparate the laſt portions of the caſeous matter in this ſtate of pellicles, we muſt take care to add, towards the end, water diſtilled from the milk; when this liquid affords no more pellicles, it is no longer ſuſceptible of coagulation.

When we evaporate the entire milk to a thick conſiſtence, we obſerve that it undergoes a real coagulation, and that maſſes are formed in it; its ſolid matter, when once thickened, aſſumes a

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yellowiſh colour however little we may heat it more ; before it acquires this colour, and when it is ſtill ſoft, though thicker and more ſolid than honey, it conſtitutes *franchipane*, a kind of ſweetmeat which is prepared by adding to the milk pounded almonds, ſugar, and orange-flowers, towards the end of its evaporation. Formerly the extract of milk was kept for preparing the whey of Hoffman by adding hot water to it. This is almoſt always a bad medicine, becauſe the extract very eaſily ſpoils, and becomes acrid and rancid.

19. When milk is heated in cloſe veſſels, and when it is evaporated on the water-bath, a large quantity of water, very little odorous and inſipid, is obtained, which preſents no phenomena by the re-agents, but which however carries along with it ſome matters in vapour, ſince it putrefies, depoſits light flakes, and becomes fetid when it is kept. This diſtilled water was formerly prepared in the laboratories of pharmacy, and great virtues were attributed to it which have at laſt been diſcovered not to exiſt. The milk is thickened and coagulated after having furniſhed this aqueous product which conſtitutes nearly two thirds of its weight, when the operation is carried ſo far as to obtain the reſiduum in the form of extract. When the extract itſelf is diſtilled by the retort it affords a turbid, reddiſh, fetid water, charged with zoonic acid and ammonia, a pretty abundant quantity of fluid oil of a

 brown

brown colour, a portion of concrete and empyreumatic oil, of ſolid and cryſtalline carbonate of ammonia, of carbonated hidrogen gas and carbonic acid gas. The coal which remains after this operation is conſiderably voluminous; by incineration it leaves in its aſhes ſome traces of muriate of ſoda, of muriate of pot-aſh much more abundant than the firſt and of phoſphate of lime. Rouelle, who found in milk the preſence of, pot-aſh in the ſtate of muriate, has remarked that this kind of alkali does not exiſt in the blood, but contains only ſoda, either pure or combined with muriatic acid. This may ſerve to prove that another matter beſides the blood contributes to the ſecretion of the milk; and if it affords reaſon to believe that it is the chyle as proceeding immediately from vegetable aliments—for it is the milk of the cow of which we ſpeak, it announces at the ſame time that the ſalts of pot-aſh change in paſſing into the blood. Both theſe conſiderations preſent chemical problems the ſolution of which is of great importance.

20. Milk expoſed to the air quickly becomes covered with a layer of light matter, of a duller white than the entire milk, which itſelf at the ſame time becomes more limpid, and aſſumes a blueiſh tinge. This white layer, which is of a bland unctuous taſte, conſtitutes the cream; it ſeparates more or leſs quickly, according to a multitude of circumſtances, and in a quantity which, in the milk of the cow, always correſponds

ponds with the goodneſs and abundance of the nouriſhment; hence the poetical expreſſion of fat paſturage. It is more yellow and conſiſtent, the more this nouriſhment is abundant and of good quality. The cream contains the butyraceous oil, which is not yet butter ready formed, with a ſmall quantity of very light and very bland caſeous flakes, and a conſiderable proportion of whey or ſerum. Though the cream alone furniſhes the butter, it never ſeparates ſpontaneouſly and without agitation; it is known that it may be converted into light and fat cheeſes. Cream is one of the products of milk upon which the quantity and quality of the nouriſhment given by the aliments has the moſt influence. It is ſingularly changed, diminiſhed in quantity, and aſſumes a diſagreeable ſmell in diſeaſes, as is conſtantly obſerved in the epidemic diſeaſes of animals. I have obſerved that the contact of the air contributes much to the ſeparation and the butyrization of cream. It is obtained more ſpeedily in flat and wide veſſels, which preſent a large ſurface to the atmoſphere, than in narrow veſſels. I ſhall revert to this phenomenon in the hiſtory of butter.

21. The entire milk, the intoxicating property of which ſome travellers have announced, eſpecially the mare's milk in Siberia, and that of the ewe in the Hebrides, is ſuſceptible of paſſing into the vinous fermentation. This art has long been practiſed by the Tartars

Tartars and the Nomadic nations. They leave the mare's milk in large buckets, and even mix it with blood, and they obtain from this mixture an intoxicating liquor which they use instead of wine. It has been found, in performing this experiment with care, that the vinous fermentation of the milk does not take place unless when it is in considerable masses; that the integrity of all its elements was requisite to the effect; that it did not establish itself well except in milk of good quality and above ten degrees of temperature; that a slight and repeated agitation of this liquid in close vessels accelerated and favoured it, by mixing well all its materials which tended to separate from each other; that there was disengaged a considerable abundance of elastic vapour, to which it was necessary to give vent from time to time, and that this was carbonic acid; that there was formed a viscid and tenacious scum, a sort of coating at its surface; finally, that the milk, whilst it underwent this intestine and vinous motion became in part acidified and coagulated. When these phenomena have taken place, the milk, which is clotted, of a pungent smell, acidulous and vinous at the same time, being subjected to distillation, by a slight ebullition, affords a product of alcohol in little abundance, and acid at last, which may be rectified by two successive distillations, and presents all the properties of this liquid, which is identical in all cases,

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as it always proceeds from one common ſource: but its quantity is always ſo ſmall that it can never be extracted from milk with advantage. It will appear that the ſlightly ſaccharine matter contained in this liquor is the true origin of this alcohol, and the cauſe of the vinous fermentation of which it is ſuſceptible.

22. If the temperature of the air exceed fifteen degrees; if the milk be expoſed to the air; if it be agitated in order to retard the ſeparation of the cream and to keep the materials well mixed together, it paſſes into another kind of fermentation, and acquires an acidity ſenſible both to the ſmell and the taſte. Every one knows that milk turns ſpontaneouſly ſour when it is kept for ſome time; that great changes of the atmoſphere, eſpecially electric commotions and tempeſts contribute greatly to this aceſcence: that it is retarded by boiling it, which is attributed to the diſengagement of its odorous matter, though it has perhaps no influence upon this property: at the ſame time that it undergoes this change the milk curdles or coagulates; its conſtituent materials ſeparate; ſolid clots more or leſs voluminous are precipitated from it; frequently even this ſeparation of ſolid matter takes place in a ſingle piece, and we ſee a white opaque, ſemi-concrete maſs, ſhrunk together, and ſurrounded with a yellowiſh liquid a little turbid, which gradually augments, and ſeparates from the ſolid maſs in proportion as the particles of the latter approach and condenſe.

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The portion of the milk thus ſpontaneouſly thickened and coagulated is called the curd, and the liquid is denominated the whey. The latter has a ſour taſte and a pungent odour; it is in proportion and at the moment when it has acquired this taſte that the caſeous matter becomes ſolid and ſeparate. In this manner a new acid is formed, which ſhall ſoon be examined by the name of *lactic acid.* In the ſpontaneous decompoſition of the milk, and in its ſeparation into ſolid and liquid matter, we find a remarkable analogy with what happens to the blood; but here it is the product of an acidification which does not take place in the vital liquid, and the compariſon if carried too far becomes a real error.

23. Though it be well proved that milk is ſuſceptible of forming by fermentation an acid of a particular nature, it is however not leſs capable of aſſuming by a ſlight modification the character of true acetous acid. Scheele has found that by mixing ſix ſpoonfuls of alcohol with about three litres of milk; ſuffering this mixture to ferment in a well-corked bottle, and taking care to give vent from time to time to the elaſtic fluid diſengaged during this fermentation, the milk was converted at the end of a month into very good vinegar. It is only requiſite to paſs it through a piece of linen in order to ſeparate the coagulated caſeous part, and then to keep it in well cloſed veſſels: it may be employed, like real vinegar for economical and domeſtic uſes.

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We ſee in this property the conſequence of the vinous fermentation and the rapid paſſage of milk into the ſtate which commonly follows wine, when we begin by adding to it a portion of the eſſential product of this fermentation: thus is eſtabliſhed a very remarkable analogy of nature between the lactic acid and the acetous acid.

24. Milk is coagulated and decompoſed by all the acids, the ſtrongeſt as well as the weakeſt. Of all the animal liquors it is that which preſents the moſt prompt and eaſy coagulation. A large quantity of curds more or leſs voluminous is formed and ſeparated from it at the very moment when an acid is poured into it; when it is concentrated and agitated a little, it produces a ſolid curd which however divides into flakes by further agitation. Every one knows the uſe of the weak acids in effecting the coagulation of milk. The curd thus formed and well drained retains no acid taſte, and the acid that has been employed remains entire in the ſupernatant liquor. It is therefore by uniting with the ſerum that the acids ſeparate the caſeous portion, and it is to its tendency to become concrete that the coagulation of this matter is to be aſcribed. This we ſee eſpecially in the curd ſpontaneouſly formed, which retains none of the acidity of lactic acid when it has been drained, preſſed and waſhed. We ſhall hereafter ſee that this effect is produced by the attraction of the acid in general for the water of the milk, by the little ſolubility of the

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insulated caseous matter, and by the little attraction of the acid for this matter.

25. The alkalies do not produce the same effect of coagulation upon milk, though they first separate the cheese from the water, and thicken this fluid at first, because they have a very strong attraction for the caseous substance. Their action upon milk has even been opposed to that of the acids, because when an alkali is added to this liquid once coagulated, the coagulum is actually re-dissolved, by strong agitation. Ammonia especially enjoys this property; it dissolves the curds formed in milk by the acids very quickly and easily: it re-establishes in some measure milk that has been turned in some hot drinks; and it is employed for fusing the milk and causing it to flow in the breasts of lying in women, when they are attacked with that very painful disease the trichiasis. Boerhaave having observed that the *oil of tartar*, or a condensed solution of pot-ash proceeding from burnt tartar, being boiled with milk, gave it a yellow colour which passed into the red, thought that this phenomenon resembled the blood, and that this liquid proceeded from a similar combination between the chyle and the alkaline humours. This effect of colouration, which never goes so far as redness, and is very different from the phenomenon of sanguification, depends upon the re-action of the alkali upon the caseous matter of the milk and upon the transition

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of this matter into the ſtate of a kind of carbonated oil, as I ſhall ſhow hereafter.

26. The ſalts, of whatever nature they may be, have conſiderable action upon the component materials of milk, in ſeparating them from each other, and it is in this manner that they decompoſe and coagulate this liquor. It can only be by their attraction for the water that they produce this effect; and we ſee that the greater this attraction is, the more ſpeedily they effect the coagulation of the milky liquid. Scheele well underſtood the cauſe and the preſence of this phenomenon.

The metallic ſalts and ſolutions act in a complicated manner upon milk, on account of the multiplied attractions exerted by the ſaline matters diſſolved in this liquid; but we muſt here confine ourſelves to the enunciation of their coagulating and decompoſing action in general, conſiſting in the ſeparation of the caſeous matter. Other details of their effects belong to the particular properties of the inſulated materials of milk, and we ſhall treat of them in the ſubſequent paragraphs.

27. It is known by all the economical uſes of milk, that this liquor unites eaſily with ſeveral vegetable matters; that combines with gum, ſugar, the amylaceous fecula, the aromatics and ſeveral colouring matters; that ſome give it a more or leſs thick conſiſtence, and agreeable taſte, a pleaſant perfume, and varied colours. But chemiſtry ſhows that theſe combinations

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are merely tranfient, that they take place only at the expenfe of the nature itfelf, and of the intimate mixture which conftitute this liquid, fo that it is more difpofed to be altered and decompofed. Scheele has proved that all thefe matters, diffolved in the milk and efpecially if heated with it, effect its coagulation and the feparation of the cheefe. He has conftantly attributed this effect to the folution of thefe matters in the water, and to the fuperiority of their attraction for this liquid over that which the cafeous fubftances has. Many flowers, grains, leaves and parts of vegetables in general exert the fame decompofing and coagulating action upon milk, though the plant which has received the French appellation of Caille-lait (*gallium*) poffeffes this properly in an inferior degree fo many others, as Citizens Deyeux and Parmentier have found. Many of thefe vegetable fubftances are employed, as we fhall fee, for infulating the cafeous from the ferous part. We find the fame effect in feveral animal fubftances, both mucous and gelatinous, fuch as the membranes of the ftomach of man, of birds, &c. fifh-glue, the fkins of all animals, whether acidulous or fufceptible of acefcency, as runnet, and animal jelly, and they are employed for the fame ufes. Alcohol alfo decompofes milk, and coagulates it into very fmall flakes, which may be immediately rediffolved in water. This feparation of the flakes of cheefe and butter proceeds, like that of

of a diſſolved ſalt from the attraction which alcohol has for water.

28. All theſe chemical phenomena of the entire milk prove that this liquid is a very compound ſubſtance, the materials of which are but feebly united with each other. It preſents itſelf as a momentary combination, a kind of ſuſpenſion of fat and oily matter in a mucous and ſaline liquid, the adheſion of which is but weak, the equilibrium little permanent, and the principles of which tend to ſeparate by a multitude of cauſes. On this account milk has been conſidered as a kind of animal emulſion, and compared to that which is obtained by the trituration of oily and mucilaginous ſeeds in water, to the thick liquid which is prepared by triturating gum and oil with this fluid; but in order to know whether this compariſon affords an exact notion of the nature and compoſition of milk, the properties of each of its component materials muſt be examined; namely, the ſerum, the caſeous part and the butter.

Section IV.

Of the Serum of Milk, or of Whey.

29. THE ſerum of milk, or whey, is the moſt abundant part of this liquid. We do not here treat of what is called *whey* in the dairies, or of the liquor ſeparated by aceſcence; it is of the ſerum not turned ſour that I intend to ſpeak, and particular proceſſes are requiſite for extracting it or ſeparating it from the milk: the following is that which is generally employed with ſucceſs. The entire milk is heated, runnet being added to it in the proportion of about a gramme to the litre: this ſubſtance, proceeding from the reſidue of the milk coagulated in the ſtomach of the calf and the gaſtric juice which is mixed with it, cauſes the milk to coagulate with facility. It is then ſuffered to boil for ſome moments, after which it is paſſed through a ſtraining cloth: there runs off a liquid ſtill turbid, which is to be clarified with white of egg and agitated in a little water; when it has cooled it is filtrated through a double paper without ſize. We may employ the membrane of the ſtomach of birds, or the flower of the thiſtle, or of the artichoke for coagulating milk. When we employ the tartarous acidule in fine powder, or vinegar, the whey which we obtain

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is not pure, but presents properties that do not belong to that fluid.

30. The whey or the serum of milk thus prepared is a liquid perfectly limpid, of a greenish-yellow colour, of a light faint and sweetish smell when hot, inodorous when cold, of a sweetish, slightly saccharine and unctuous taste. Its specific gravity is a little less than that of the entire milk; Muschenbroeck had estimated it at 1016, the milk from which it proceeded being 1030; Citizen Brisson gives for the specific gravity of the milk of the cow 10,324, and for that of the clarified whey which was extracted from it, 10,193. Previous to its clarification it still contains a small quantity of caseous matter, which impairs its transparency and is suspended in it in flakes. By a mild heat continued for some time, it clears and deposits these flakes. It is also, in this state, turbid, and of a greater density than after its clarification. The density of this purified liquor proves that it is very different from water, which is also confirmed by its colour and taste: accordingly, whey is a very nourishing liquor. Besides those patients who are supported and sometimes even too highly nourished with this animal liquor, the history of the arts presents two remarkable facts respecting this property, which relate to two celebrated men. Boerhaave lived several successive months without any other nourishment than whey, and Ferguson made it his nourishment during eighteen whole years,

adding to it only a ſimple decoction of barley.

31. The action of heat upon whey affords reſults different from thoſe which milk preſents. When evaporated in open veſſels, or diſtilled on the water-bath, there is ſeparated from it a large quantity of ſlightly odorous water, which contains nothing ſenſible to the re-agents, though it becomes altered by putrefaction; the whey becomes coloured, grows brown, turbid, thick, becomes viſcous and concrete like granulated honey: if in this ſtate it be heated in a retort, it does not furniſh the ſame products as the entire milk; they have not the ſame fetidity; they do not contain an equal proportion of carbonate and of zoonate of ammonia; we find in them on the contrary pyromucous acid and ammoniacal pyromucite; the gas is leſs carbonated hidrogen than carbonic acid; the coal which it leaves is light and burns eaſily; we find in its aſhes a ſmall quantity of carbonate of pot-aſh, of muriate of ſoda, and more of the muriate of pot-aſh and phoſphate of lime.

32. When we evaporate the ſerum of milk to the conſiſtence of a ſyrup, and afterwards let it cool ſlowly, there are depoſited from it irregular cryſtals of a brown yellow colour, of a fat and unctuous appearance, which, when re-diſſolved in water and purified by two ſucceſſive operations, paſs through the yellow tinge and at laſt arrive at the ſtate of white cryſtals in regular paralelopipeds. This matter is

is what is called the ſalt or the ſugar of milk; a ſubſtance very remarkable in its properties, and which deſerves to be ſtudied with attention.

Kaempfer aſſures us that the Brachmans have long known the art of extracting the ſugar of milk. Fabr. Barthollet or Bartholdi, an Italian phyſician, was the firſt who made expreſs mention of it, in 1619. Etmuller, Guterman, Teſti, Werloſchnigg, Wallerius, Fickius, Cartheuſer, Vulgamoz, and Lichtenſtein have ſucceſſively written its hiſtory and examined its properties. Rouelle the younger, Scheele, Hermſtadt, Citizens Deyeux and Parmentier have eſpecially occupied themſelves with its nature and chemical compoſition. We ſhall ſee that notwithſtanding the labours of theſe able men, there ſtill remains ſomething to be deſired reſpecting this ſingular ſubſtance, the formation and the exiſtence of which in the milk preſent conſiderations of great importance to the phyſiologiſt.

33. The ſugar of milk is prepared in conſiderable abundance in the mountains of Switzerland, a country ſo renowned for the excellence of its paſturages, and for that of the milk of its cows, as well as its different products. They take the ſerum obtained from ſkimmed milk coagulated by runnet, boil it and evaporated it freſh, before it turns ſour, till it has acquired the conſiſtence of a thick ſyrup, and becomes fixed into a granulated matter by cooling. It is then poured into earthen moulds like the boiled juice of the ſugar-cane; in which

it condenses into a mass which is dried in the sun : sometimes it is poured into vessels with flat sides, in which it assumes the form of cakes. It is very impure in this first operation; it is refined by dissolving it in water and clarifying the solution with white of egg; it is boiled again to the consistence of a thick syrup, which is suffered to crystallize gradually by cooling: and thus afford white crystals in rhomboïdal paralelopipeds. The mother-water which is decanted from the crystals deposits others of a yellow or brown colour which are successively purified or refined. It is not without great difficulty that some rudiments of crystals of sugar of milk are obtained in the small way in our laboratories; but we separate this body in the granulated and honey-like form. It appears, when we take the average term of the proportions which authors have indicated in the different kinds of milk, that the maximum of its quantity is one-twenty-eighth and the minimum one-sixtieth of the milk.

34. M. Lichtenstein has made the analytical examination of the different varieties, or rather of the different states of the sugar of milk, which are sold at different prices in the Helvetic Republic. The following are the principal of them which he distinguishes :

A. *The white and pure sugar of milk*, extracted from the purified serum.

B. *The acescent sugar of milk* extracted from whey

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whey that has turned four: it is coloured, fatty, moift, and impure.

C. *The fugar of milk mixed with mother-water or fatty parts*, as the author calls them, is that which feparates in the firft cryftallization.

D. *The fugar of milk mixed with oil and muriate of foda*, which cryftallizes the laft.

E. *The fugar of milk mixed with fat parts, with muriate of foda, and with muriate of ammonia;* this is adhefive and moift; it affords ammonia by the fixed alkalis.

F. Finally, a variety of fugar of milk mixed with all the fubftances already indicated, and alfo with an extractive part and cafeous matter. This laft, the moft impure of all, becomes rancid: and in this ftate it is acrid and pernicious. In France, the different varieties of thefe fugars of milk are not known.

35. The falt or fugar of milk, when well purified and cryftallized, prefents to the chemift properties which belong to no other fubftance. It is white, cryftalline, of a faint tafte, and feemingly earthy, notwithftanding the name which it bears, unalterable by the air: it is much lefs foluble than fugar, fince four parts of hot water are required for the folution of one part of it; more than twelve of cold water are requifite. Placed upon ignited coals, it becomes brown, fufes not fo well nor fo fpeedily as fugar, exhales white fumes, having a pungent odour of caramel, the fumes of which they refemble, fwells, inflames, and leaves a black

black coal, lefs light, rather eafy to be incinerated, leaving $\frac{1}{100}$ (30 grains in the pound) of the weight of the primitive falt, in which Rouelle has found a mixture of three-fourths of muriate of pot-afh, and one-fourth of carbonate of pot-afh. Diftilled in a retort, it affords water charged with pyromucous acid, fome drops only of red oil, much carbonic acid gas, mixed with carbonated hidrogen gas, and a light coal of the nature already indicated. According to its properties, Rouelle and Vulgamoz have confidered it as real fugar. Scheele has confirmed that opinion by converting this matter into oxalic acid by means of nitric acid.

36. But a particular difcovery of Scheele, relative to this fugar of milk, has however fhown that this kind of mucous body prefents a very effential difference from fugar properly fo called. In treating it with the acid of nitre, he remarks that it required more to change it into oxalic acid; that it afforded only a little more than one-eighth of its weight of this acid; and that there was gradually feparated from it a white powder, little foluble, in which he found the characters of a particular acid which he calls *acid of fugar of milk*, and which has fince been defignated in our nomenclature by the name of *fachlactic*, and of which I have given the hiftory, under that of *mucous acid*, in the article concerning gum or vegetable mucus, becaufe this fubftance has, like the fugar of milk, the property of affording it by

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the action of the nitric acid. It has been seen in this article that Mr. Hermstadt, who has inserted in Crell's Annals of Chemistry two Memoirs upon the sugar of milk, believed that the mucous or sachlactic acid was oxalate of lime disguised by a fatty matter; but Scheele, who had also suspected the same could not verify it, nor has it received more confirmation from our experiments. From the little taste and solubility of the sugar of milk and its property of forming mucous acid like gum, I consider it as a sort of intermediate substance between the mucous substance and sugar; I believe it to be the product of the work of digestion; for it is formed in the carnivorous animals, in the milk of which it is even abundant, as well as in the frugivorous, and it is difficult to believe that it passes immediately from the stomach into the mammæ by the chyle. Perhaps it may be this mucoso-saccharine compound which is found in the urine of persons labouring under the *diabetes mellitus*. Citizens Deyeux and Parmentier believe that the sugar of milk, which they assert to be more soluble in milk than in water, is a combination of sugar and sachlactic acid, and that it may be formed artificially by uniting these two matters. I have no knowledge nor can I say any thing concerning the experiments upon which they ground this assertion, which I must confess however appears to me to accord very ill with what we know of the properties

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of the two ſubſtances which they ſuppoſe to be combined.

37. When we have obtained all the ſugar of milk contained in the ſerum, the liquid which remains as mother-water is brown, viſcous, thick, and gluey; it affords by cooling, as Rouelle the younger remarks, an almoſt tranſparent jelly, and it concretes into a tremulous maſs, like an animal decoction. It is in this mother-water alſo, that ſeveral ſaline matters exiſt, which may be ſeparated from it, if after having diluted it with a ſmall quantity of water, it be evaporated very gently, and with the attentions with which experiments of this kind ought to be conducted. They are cubes of muriate of pot-aſh which depoſit themſelves thus in the cryſtalline form: the phoſphates of ſoda and of lime, which form part of the depoſit, and which other experiments enable us to diſcover in it, are too little abundant and too much diſguiſed by the former cryſtals, to be perceptible in it. The re-agents by which they are indicated preſent particular phenomena with the entire milk previous to its evaporation or concentration; theſe are the alkaline and metallic ſolutions. Lime-water, the ſolution of ſtrontian and of barites precipitate the ſerum of milk very ſenſibly; the precipitate is an inſoluble earthy phoſphate. Pot-aſh, ſoda, and ammonia form in it a light maſs, which is only precipitated phoſphate of lime. Amongſt the metallic ſalts, the nitrates of mercury and ſilver

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are those whose action upon the serum of milk has been the best examined. The first forms in it a precipitate of a greyish-white colour, which becomes rose-coloured by drying in the air; the second, in precipitating it, remains in a white powder. Both these precipitates afford traces of phosphorus when they are distilled alone or with pulverized charcoal at a sufficiently elevated temperature. They are composed of metallic muriate and phosphate coloured and soiled by a gelatinous animal matter. The action of the acids upon whey, has nothing remarkable; the concentrated sulphuric acid colours and reduces it to coal; the nitric changes it into oxalic and sachlactic. The concentrated whey turns syrup of violets green: Rouelle the younger attributed this colour to the yellow of the liquor.

38. We see that by the preceding re-agents the serum of the milk is altered only as to its saline substances, that they alone produce the effects announced, and that the mucoso-sacharine and gelatinous substances, which however constitute its principal materials, (for the salts amount in it only to some thousandths,) experience no change or alteration, at least not perceptibly by their precipitation by means of these re-agents. Indeed it cannot be doubted that the caustic alkalies and the powerful metallic salts act upon these two organic substances, as is indicated by the change of the colour of the fluid, and the colouration of the

the precipitates; but these slight modifications are but little appreciable. Thus the object of the chemist, in treating whey by the re-agents, is particularly to exhibit its saline properties. There are, however, also means, without other re-agents, of separating and obtaining distinctly the mucous and gelatinous compounds, and of distinguishing them from each other, and from the saline materials that are mixed with them. When the serum of milk thickened and concentrated by fire has acquired the consistence of a thin syrup; if we throw into it a sufficient quantity of alcohol, a flakey and mucous deposit is formed which contains the sugar of milk, and the gelatin, equally insoluble in this liquid, and separated from the water by reason of the strong attraction which it has for alcohol. The serum thus thickened may be precipitated, though little abundant, by tannin which seizes only the gelatinous substance which it contains, and we may afterwards find again in it the mucoso-saccharine salt which it contains by the addition of alcohol, which precipitates it in its turn.

39. I have strongly insisted in my experiments on the analysis of the serum of milk upon the presence of the phosphate of lime, which, by its quantity, has appeared to me to follow immediately after the muriate of pot-ash. We find it in the ashes of whey when entirely evaporated and burned, or in those of

of the coal which it leaves after its diſtillation. It is this which is precipitated by the addition of pot-aſh, of ſoda, and of ammonia, in well clarified whey, and the precipitation of which becomes much more ſenſible which this humour has been previouſly concentrated by evaporation. The oxalic acid which conſtantly renders the ſerum turbid, and forms in it a precipitate of oxalate of lime, affords alſo the proof of its exiſtence by the earthy baſe which it takes from it: the phoſphates of mercury and lead which are obtained by the nitric ſolutions of theſe metals, and which contain its acid, complete the proof. The little ſolubility of this ſalt, and its exiſting neverthelefs in the proportion of ſeveral thouſandths in milk, prove that it enters into the plan of nature to furniſh it conſtantly to the young animals in this firſt nouriſhment which they take ſo greedily and ſo abundantly. I have thought I had found the reaſon of this view of nature in the rapidity and energy of oſſification at this tender age of life.

40. One of the moſt characteriſtic properties of the ſerum of milk is that it turns ſour with great facility: perhaps it paſſes previouſly into the vinous fermentation; but this is ſo feeble and ſlight, that it is difficult to ſeize the inſtant of the tranſition. The aceſcence on the contrary is the moſt conſtant and the moſt marked phenomenon which this liquid preſents in the courſe of its ſpontaneous alterations. It is by this

this motion that the lactic acid is formed. The whey commonly becomes turbid and deposits some light flakes of caseous matter in proportion as it becomes sour: if we add two or three spoonfuls of alcohol to each litre of this serum, we obtain acetous acid instead of lactic acid, as with the entire milk. I have already remarked that Scheele in examining milk that had spontaneously become sour, discovered a particular acid in it: he has given both the means of purifying it and the history of its principles and combinations. No chemist has added any thing to the work of Scheele. It is proved that the formation of this acid is owing to the alteration of the sugar of milk or of its mucoso-saccharine matter; for when this acid is once well formed, when the whey having become strongly acid intensely reddens the blue vegetable colours, we no longer obtain this matter from it by evaporation and crystallization.

41. Scheele not having been able to succeed in separating the acid of sour whey by distillation, but having obtained by this operation only a little acetous acid, the formation of which appears constantly to accompany that of the lactic acid, endeavoured to obtain this fixed acid by other means. The following is that which succeeded the best with him, and which, though complicated, proves the sagacity and extensive resources of this able chemist. Sour whey is evaporated to an eighth of its volume by

by a very gentle fire; it is filtrated in order to separate from it all the caseous matter thus coagulated in flakes; lime water is added to precipitate the animal earth, that is to say, the phosphate of lime; it is then diluted with thrice its weight of pure water, and the excess of lime is precipitated from it by the oxalic acid, the latter being added in no larger proportion than is necessary, and so that an addition of lime-water shall form in it neither cloud nor streaks; the liquor is evaporated to the consistence of honey, alcohol is then poured into it, which separates the portion of sugar of milk or other extraneous matter, and dissolves the lactic acid; lastly, the liquor being drawn off clear is distilled till all the alcohol that has been added is collected: and what remains in the retort is pure lactic acid. The following are the specific and charactereſtic properties which the Sweedish Chemist has found it to possess.

42. It has a rather strong sour taste which is not agreeable; it is in the liquid and viscid form when concentrated; it reddens the tincture of turnsole well, and it gives a violet-red tinge to the syrup of violets. Evaporated even to a very dense consistence, it does not assume either the crystalline or granulated form; but it has a muciliganous viscosity. Distilled in a retort, it affords a pretty strong empyreumatic acid analogous to the pyrotartarous, with very little oil, and the carbonic acid and carbonated hidrogen gases, and a coal in little abundance adhering to the glass.

glass. When united with the three alkalies, with barites and with lime, it forms salts little crystallizable and deliquescent. Its combination with magnesia crystallizes, but it also attract the moisture of the atmosphere: most of these earthy and alkaline lactates are soluble in alcohol. The lactate of ammonia is not known, neither are those of alumine, of glucine and strontian; what Scheele has given us relative to the properties of these salts is still only a first notion. We find in it nevertheless relations with that of the acetites: however the lactic acid decomposes the acetites.

43. The combinations of the lactic acid with the metallic oxides have also occupied Scheele; but he studied only what appeared to him to be necessary for distinguishing and characterizing the lactic acid, and he had not the intention of examining their complete series: so that his work presents in this respect only a slight outline of what the science requires. According to his enquiries, the lactic acid does not in any manner attract cobalt, bismuth, antimony, mercury, silver and gold, notwithstanding the long duration of contact between these bodies and even with the aid of ebullition. Zinc and iron are oxided and dissolved in it, as in almost all the acids, with disengagement of hidrogen gas: which announces that they decompose the water, that the lactic acid augments their attraction for the oxigen, that it favours and accelerates the decomposition of the water,

and

and that these two metals contract no adhesion with it till after they have previously been oxided. The lactate of zinc crystallizes; that of iron forms only a brown deliquescent mass. The same acid oxides and dissolves lead and copper. Frequently, during the solution of the first of these two metals, a small quantity of sulphate of lead is precipitated, which announces the presence of a small quantity of sulphuric acid in this acid.

44. We see, according to this faithful exposition of the labours of Scheele upon the acid of soured whey, how much is still wanting of facts in order to make us thoroughly acquainted with its properties: those which he has described are merely sufficient to prove that it is a particular acid different from all others. Besides the great number of its saline compounds which are still wanting to the science, Scheele has not indicated the action of fire upon this acid, its spontaneous alteration in the air, its habitudes with the nitric acid, &c.: it is not known whether it is totally decomposed by the latter or converted into another acid, especially the oxalic, as several vegetable acids are. Its intimate nature and composition are entirely unknown: though it presents properties which approximate it to the acetous acid, and which may lead us even to believe that it is very similar to it, I still find it impossible to rank it amongst the vegetable acids. On the other hand, I find it equally impossible to adopt a decided opinion relative

relative to its animal nature, since no experiment has hitherto exhibited the presence of azote in it, and since it is unknown whether it can afford ammonia in its decomposition, whether it is putrescible, whether it can be converted into Prussic acid, as we know can be done with all the well characterized animal matters. It must therefore be a subject of research for chemists, if they wish to acquire a more positive knowledge concerning it.

45. It may be inferred from all the facts contained in this paragraph, form all the analytical experiments upon the serum of milk or whey, of which I have just given an account, that this liquid is composed of a large quantity of water, of a variable proportion of mucoso-saccharine crystallizable matter, of gelatin and of some saline matters, especially muriate of pot-ash, perhaps of sulphate of pot-ash and phosphate of lime; that the two first substances render it sweet, saccharine, susceptible of fermentation, of acescence, of affording nourishment, of crystallizing, of concreting into a jelly, of being precipitated by tannin; that the salts, and especially the phosphate of lime are the causes of its precipitation by the alkalies, of the traces of phosphorous which its metallic precipitates treated by an intense fire yield; that the knowledge of these constituent materials explains its nutritive quality and its special advantage as the first aliment of young animals; that this composition of the serum of milk may be regarded with respect to it two most

moſt abundant principles, the mucoſo-ſaccharine ſubſtance and the gelatin, as the natural link which contributes to hold a ſlight combination with the other materials of the milk, and eſpecially the butter; finally, theſe two matters perform in ſome meaſure the office of the gum in loches, or of the mucilages in the emulſions of vegetable ſeeds.

Section V.

Of the Caſeous Matter and of Cheeſe.

46. THE caſeous part of milk is obtained by means of a great number of different ſubſtances which have the property of turning or coagulating it. In order to obtain this ſubſtance pure, we muſt be careful to take ſkimmed milk, that it may not be mixed with butyraceous matter. Runnet, the flowers and the receptacles of moſt of the compoſite or ſynginefian plants, and all the aſtringent plants, have the property of curdling or coagulating milk in the cold with the aid of a little time; the acids, whatever they may be, have the ſame property; and as they remain diſſolved in the ſerum, we may employ them, provided we uſe them weak and in ſmall quantity, for obtaining the caſeous part. We may alſo employ the dried membranes of the ſtomach and inteſtines of animals, glues,

 jellies,

jellies, and membranes, which produce the ſame effects. We have already ſeen that alcohol alſo acts in the ſame manner in the decompoſition of milk. The caſeous ſubſtance is ſeparated, either in the form of ſmall inſulated flakes, or in that of a kind of tremulous matter in a ſingle white and opaque piece, or in that of thick maſſes which tend to condenſe and harden.

47. In dairies the milk is turned by different means, but eſpecially by runnet employed cold, for preparing cheeſe. Theſe are in general of two kinds accordingly as they have been prepared either with entire or pure milk, or with ſkimmed milk. The firſt conſtitute the fat unctuous cheeſes, which retain a ſoftneſs and opacity, which have a fine and ſweet paſte, and by a ſlight alteration run and form a ſort of thick ſyrup, as we ſee in the good cheeſes of Brie. Skimmed milk affords a hard aud ſolid caſeous maſs, which becomes dry and brittle, and, when ſtrongly compreſſed acquires a ſemi-tranſparency and conſtantly preſerves its ſolidity, growing hard inſtead of ſoftening and running. In order to fabricate and preſerve them they are put to drain upon hurdles, they are ſalted and kept in low and moiſt ſituations, they are ſometimes incloſed in hoops of thin and flexible wood or bark, which are bended round their ſides and cloſed every day ſo as to diminiſh their diameter; they are alſo ſalted at their ſurface. By theſe proceſſes the water of the caſeous matter is preſſed out, its flakes

are brought nearer together, and they are made to acquire a homogenous confiftence throughout their whole continuity.

48. There are many differences in cheefes, according to the diverfities of the milk, the nature of the runnet which is employed for feparating and precipitating them, the art of preffing, kneading, draining, drying and expofing them to different degrees of alteration or of fermentation; according to the quantity of whey which is left in them, the force of preffure which is employed, the temperature to which they are fubjected, the kind of package or piling which they undergo, the time during which they are treated in this manner; laftly, according to the general combination of all the circumftances which prefide in fome refpect over their preparation. In order to obtain cheefes with a dry, denfe, femi-corneous and femi-tranfparent pafte, like thofe of Gruyere; the cafeous matter being feparated from the coagulated milk is kneaded in the hands: after it has been properly worked, it is drained upon hurdles or compreffed and kneaded anew; the cheefes are preffed and the ferum forced out of them, not only moveable by the hoops which are brought clofer every day, but alfo with weights placed upon them after they have been piled one upon the other; when once dried they are falted at feveral times; the white and blue mould which forms upon their furface

is repeatedly ſcraped off; this is diſcontinued when this mould formed upon the dried rind has aſſumed a red colour; the fermentation is conducted ſlowly and gently till it has communicated to the cheeſes the taſte aud ſmell which ought to charaſterize them. This operation is performed in ſubterraneous buildings, or cool vaults, and at a conſtant temperature of between 2 and 5 degrees + 0. Such are the ſo famous cheeſes of Roquefort.

49. It is not upon theſe cheeſes prepared by art and more or leſs altered by a fermentation which none of them eſcapes, and which is conſtantly obſervable in all or almoſt all theſe alimentary preparations, that chemiſts make the experiments proper for aſcertaining the properties. It is to this matter in its freſh ſtate, not altered but ſtill natural, ſuch as it is precipitated from the milk at the very moment of its decompoſition, that they direct their attention, and upon which they perform their experiments. The caſeous ſubſtance, which is not yet cheeſe, obtained in this manner and well preſſed, is in the form of white granulated flakes, eaſily ſeparable from each other, ſuſceptible however of being cruſhed under the finger like a ſort of paſte, of a ſweetiſh taſte which is not diſagreeable. It powerfully retains the laſt portion of ſerum lodged between its interſtices, and a great degree of preſſure is requiſite in order to dry it completely; it is then denſe, brittle, and begins to aſſume a ſemi-tranſparency: in this

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ftate its afpect prefents the notion of a concrete albuminous fubftance. The average quantity of the cafeous fubftance is eftimated at $\frac{1}{1}$. of the entire milk. There are great varieties in this proportion,

50. The cafeous matter, well condenfed, kneaded and deprived of all the ferum by preffure, and well feparated from the butyraceous fubftance, in confequence of being extracted with care from fkimmed milk, expofed to a gentle fire gradually augmented, foftens, becomes ropy, and as it were glutinous and elaftic; if acted upon by a ftronger fire it entirely melts, fwells, becomes brown, exhales a thick fume of a very fetid and ftrongly ammoniacal fmell, and at laft takes fire, flafhes of white and brilliant flame efcaping from feveral points; it leaves a pretty denfe coal. If we diftil it in the retort, we obtain a red, turbid and fetid water, charged with zoonate and carbonate of ammonia, a very thick oil, almoft concrete, of a deep brown colour and of an infupportable fmell, concrete ammoniacal carbonate foiled by a little oil, much carbonated and fulphurated hidrogen gas, with carbonic acid gas, and a hard coal, adhering to the glafs, brilliant, difficult to be burned, the afhes of which prefent in analyfis only a little muriate of foda, and the greater part phofphate of lime. No carbonate of foda or metallic oxide is found in it.

51. Expofed to the air in its dry ftate, the cafeous matter remains and is preferved with-

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out alteration; but if it retains a portion of ſerum between its parts, it firſt turns ſour at a temperature exceeding 12 degrees; it afterwards putrefies, ſoftens at its ſurface; there flows from it a kind of fetid ſanies; ammoniacal gas is diſengaged from it, and inſupportable fetid odour, that ſubſiſts for a very long time, very tenaceous and which appears to be owing to a compound gas, that eſcapes but very ſlowly and with much difficulty; it paſſes at the ſame time through ſeveral ſucceſſive tinges, orange, red, brown, blue, &c. Every one knows the horrible infection diffuſed by old or putrefied cheeſe, and the adheſion, the kind of fixity which this odorant ſubſtance acquires upon different bodies, the wood-work and even the walls which are impregnated with it. The total decompoſition of this ſubſtance is of a very long duration, and it preſents, like the fleſh and other animal ſuſtances already indicated, a fatty and very fuſible body, reduced to an ammoniacal ſtate by the ammonia, the complete deſtruction of which laſts for a great length of time: the contact of water in abundance abridges its duration.

52. Cold water ſcarcely diſſolves cheeſe at all; it holds its moſt divided flakes for a longer or ſhorter ſpace of time in ſuſpenſion; boiling water, without really diſſolving it, ſoftens it and contracts a pretty ſtrong adheſion with it. Scheele has obſerved that the caſeous ſubſtance, precipitated

precipitated by an acid foreign to the milk, is partially ſoluble in boiling water; but this ſolution does not ſucceed unleſs it be effected at the very moment when the ſubſtance has juſt been precipitated: if we leave its flakes for ſome time to unite and condenſe, it is no longer poſſible to accompliſh it. When the caſeous matter has remained for a ſufficient time in cold water, we find it converted into a fat, unctuous, fuſible body, very ſoluble in the cauſtic alkalies and of a fetid ſmell. Water therefore accelerates the ſpontaneous decompoſition to which this animal matter is naturally ſo much diſpoſed. This is the reaſon why dry cheeſes, expoſed in moiſt places, ſoften, increaſe in weight, acquire a ſmell, a taſte, in ſhort a ſtate, different from what they had at firſt; it is in this manner that they are matured according to the common expreſſion, and thoſe qualities are given to them which are ſo much in requeſt amongſt perſons who prefer of this kind of food.

53. The powerful and concentrated acids act rather ſtrongly upon the caſeous matter, and diſſolve it eaſily with the aid of heat; but if diluted with water, or naturally weak, they do not by any means exert the ſame action upon it. The nitric acid turns it yellow, diſengages from it azotic gas, Pruſſic acid and carbonic acids, and changes it partly into fatty matter, partly into oxalic acid. There is alſo formed a ſmall quantity of bitter matter, which adheres

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in a great meaſure to the yellow oil and which colours the fingers.

The cauſtic alkalies, in highly concentrated leys, alter the caſeous matter at the very moment of their contact; and ſeparate from it azote and hidrogen, which immediately unite into ammonia, and they convert its reſiduoual portion into a kind of oil with which they unite in the ſaponaceous ſtate. Ammonia diſſolves the caſeous matter rapidly and abundantly when recently precipitated or coagulated, and this ſolution is conſidered as one of the moſt ſpeedy and powerful. Quick-lime forms with this matter, when ſtill humid, a kind of paſte ſuſceptible of great ſolidity and adheſion: this mixture is employed as one of the beſt cements for porcelain. There is reaſon to believe that a ſtill more ſolid cement might be made with barites and ſtrontian.

54. The ſalts have not the ſame ſolvent action upon the caſeous matter, but almoſt all of them oppoſe its ſpontaneous decompoſition; accordingly the muriate of ſoda is more eſpecially employed both as a means of preſervation and as ſeaſoning, in order to make the cheeſes keep, and to retard the ſeptic alteration which tends to deſtroy them. An old prejudice, which I have already combatted, has cauſed it to be aſſerted that the ſmall quantity of this ſalt accelerates their fermentation; but it is eaſily found by obſervation that it is not with the intention of favour-

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ing it that this ſaline condiment is employed, but rather with that of limiting it, by covering the ſurface, by abſorbing their humid portion, by concentrating their commencement of their ſeptic alteration in their centre, or confining it to their exterior part, according to the ſoft or ſolid nature of theſe preparations. The ſame is the care with the oxides and eſpecially the ſalts of metals, which condenſe, contract, dry, and conſequently preſerve the caſeous matter, either by the approximation of its molecules, or by abſorbing its humidity, or by preſerving it from the external moiſture.

55. Many vegetable ſubſtances are ſuſceptible of uniting with the caſeous matter when freſh, ſoft and humid; it is rendered miſcible with water by triturating it with mucilages; it adheres to the ſaccharine ſubſtance; it becomes charged with ſeveral colouring matters; it unites by trituration with the fecula; it combines with tannin, and becomes hard and dry in this tanned combination. Its habitudes with the animal ſubſtances are as yet not well known; no attempt have yet been made to determine its relations with the albuminous and gelatinous liquors, with the fat juices, with fibrine, with the moſt complicated animal liquors, though it is eaſy to be conceived that inquiries of this kind might procure an acquiſition to animal philoſophy, by aſcertaining the miſcibility, the ſolubility, the re-action and the reciprocal alteration which thoſe different organic

organic compounds may present amongst themselves. It is very evident that this caseous substance is intimately mixed with the butyraceous oil and the gelatin in milk, and that it is to these substances that owes its solubility or adhesion with water, which forms the vehicle of the different materials of this liquid.

56. All the lights that have been acquired relative to the properties of the caseous substance have induced modern chemists to think that this substance has a remarkable analogy with albumen; and in fact it is amongst the different animal materials that which the caseous substance resembles the most in its coagulation by the fire and by the acids, its solubility in ammonia, its products in distillation, or its alteration by the nitric acid. But notwithstanding this analogy, there are however some remarkable differences between the albumen of the blood and the caseous substance, which indicate, that though the latter proceeds from the blood, it has undergone in separating from it, and in order to assume the milky form, a modification which has not yet been appreciated. Citizens Deyeux and Parmentier believe that it is to the caseous substance that the milk owes its opaque whiteness, and not to the oily particles suspended by its combination with them, that it is consequently inaccurate to compare milk to an emulsion. If they possess facts in support of this new mode of considering the union of the caseous part with the

the water, we ſhould ſee in the opacity of this ſolution a ſufficiently demonſtrative indication of a more advanced oxigination in this ſpecies of albumen of the cheeſe, than in the other known ſpecies of this animal matter. We ſhould even find here a rather ſingular analogy between the caſeous albumen whitening water by its ſolution and the cerebral albumen which dilutes in it, partly diſſolves in it, and equally gives to water the emulſive appearance.

Rouelle the younger has eſtabliſhed a marked analogy between the caſeous matter and the glutinous ſubſtance of the flour of wheat; he ſucceeded by ſalting and kneading the latter with muriate of ſoda and a ſmall proportion of diluted ſtarch, in giving to the farinaceous glutin moſt of the characters, the taſte, the ſmell, the unctuoſity of cheeſe, and he exhibited in his lectures ſpecimens, which by this preparation, had acquired the properties of old cheeſe in ſo characterized a degree that it was no longer poſſible to diſtinguiſh them from it.

SECTION

SECTION VI.

Of the Butyraceous Matter, and of Butter.

57. I DISTINGUISH the butyraceous matter from butter, becauſe the firſt, being contained in the milk at the moment when it is formed, is not yet butter, and becauſe this laſt exiſts only when the milk has remained for ſome time at reſt after having been drawn from the animal which affords it. It is with this ſubſtance relatively to theſe two ſtates as with the caſeous part and cheeſe: the firſt, being contained ready formed in the milk, may be ſeparated from it without intimate alteration; but it becomes cheeſe, as we have ſeen, only by undergoing a more or leſs conſiderable modification and change, from even the freſheſt cheeſe to that which is the moſt advanced or the neareſt to its putrid decompoſition. Butter preſents in its ſeparation and formation a ſtill more conſiderable difference from the milky ſtate than the caſeous matter does, at leaſt as far as concerns its mere precipitation from the milk. It is upon this remarkable point in its hiſtory that I ſhall firſt dwell, as it has not yet been properly treated by the chemiſts who have gone before me. In 1790, I publiſhed, according to a ſeries of experiments made

made in the courſe of the lyceum of this year, a new point of theory, relative to the formation of butter. I remarked that the cream was formed more abundantly in the air than in cloſe veſſels and in vacuo; that it was neceſſary it ſhould remain expoſed to it for ſome time, in order to render it capable of affording butter; that butter could not be extracted from recent cream; that in proportion as it remained in the air, it became more ſolid, condenſed, and aſſumed a yellow colour; that it required at leaſt four times longer ſpace of time to ſeparate the butter from cream formed in twenty-four hours, than to extract it from cream eight days old; and that all this proved an action of the air, which contributes to the formation of the butter, to its concretion, and ſeparation.

58. The production of the butter is to be underſtood in the following manner, according to the conſtant facts well known in all dairies and farms. The butyraceous matter, contained in the milk in the ſtate of a liquid, and white oil, ſuſpended in the ſerum, with the aid of the mucoſo-ſaccharine body, and of the caſeous ſubſtance, ſeparates, by means of repoſe, and ſwims at the ſurface, with a ſmall portion of ſerum, and of caſeous flakes, to which it adheres. This compound, which is more oily and more light than the ſerous and caſeous liquor, in proportion as it obtains the contact of the air by remaining above this liquor, abſorbs the atmoſpheric oxigen, becomes ſolid, concrete, coloured;

coloured; in ſhort, real butter. However, butter may be prepared with milk newly drawn, by agitating it for a long time; whence I conclude, that there is in the milk a ſufficiency of oxigen to ſaturate the butyraceous matter by this percuſſion. On the other hand, there are ſome creams, from which butter cannot be extracted by churning them for a great length of time, and which we are obliged to abandon as to that purpoſe. In general the cream is left expoſed to the air for five or ſix days before the butter is churned; and in the great rural eſtabliſhments, this operation is performed only twice every decade: there are many varieties in the properties of milk, relative to the quantity and the quality of the butter which it affords, and ſtill more particularly with reſpect to the facility with which the butter ſeparates from it. A connected ſeries of obſervations, and ſome ſingle experiments, would be requiſite, in order to determine the cauſe of theſe varieties.

59. Chance firſt preſented the ſeparation and concretion of the butter in agitated milk: the ſkins in which the Tartars, and the paſtoral nations tranſport their milk, whilſt they inceſſantly change their abodes, and wander in the deſarts with their beaſts, muſt have exhibited to them this product concreted into ſolid lumps by agitation and percuſſion againſt the ſides of theſe veſſels; and the agreeable taſte of this product muſt have recommended its uſe, and

dictated

dictated to them the art of providing themselves with it; accordingly, we find traces of it in the most remote antiquity, which are lost even in the first traditions of the human race. The mode of churning the cream, or the butter, varies according to the countries, and the quantity of it that is fabricated: it is in general by turning or moving with rapidity, an axis provided with fans, or kinds of agitators, in vessels more or less capacious, which are in part filled with cream. They are kinds of churns; the former fixed horizontally, the latter placed vertically, which serve for the operation. During a percussion, or rotation of some hours, the motion of the axis, and of the fans which it bears, after having been gradually impeded, is suddenly stopped by the mass of butter which adheres to it, and attaches itself entirely to it. This mass is afterwards kneaded in water, in order to separate it accurately from the portion of whey and of caseous flakes, which are interposed in it.

60. We see from this description, that butter is obtained from the milk but slowly, and by means of a long and violent agitation, which modifies the butyraceous matter, by causing it to absorb a portion of the oxigen of the milk; that it is much easier to be prepared with cream, and that a much less considerable percussion then effects its concretion; that older the cream is, the more speedily the operation is performed; that the butter does not

therefore exist ready formed in the milk; and that at the moment when it is saturated with the oxigen it requires, the butyraceous matter is converted into butter and quickly concretes into a mass, which no longer adheres to the serous liquor of the cream, because the attraction between its own particles is more considerable than that which it has for the other principles of the milk. When this production, and separation of the butter have taken place, there remains a yellowish liquor, sometimes of a slight orange colour, which is called butter-milk: it is more fluid than milk that has not been deprived of its cream, of a mild and agreeable taste, altogether similar in its nature to milk that has been entirely deprived of its cream. Citizens Deyeux and Parmentier have made a particular examination of it: they have found that butter-milk is coagulated by runnet with great difficulty, that the acids and alcohol separate caseous matter from it easily and speedily in very fine flakes; and that it has a very great disposition to turn sour.

61. Butter, thus prepared, is generally of a yellow colour: there is some which is white, like a kid of fat; this is considered as inferior to the former. It is believed that this difference of colour depends upon the nature of the aliments; but it is well known to the country people, that it depends upon the diversity of the individuals that afford the milk; that one cow will constantly give white butter, and another

other yellow butter. The contact of the air alſo influences the colouration of the butter; old cream affords yellow, and new cream paler butter. The lumps of butter expoſed for ſale, are of a deeper yellow colour at their external ſurfaces, than in their interior parts. Freſh butter has a ſweet and unctuous taſte, which is very agreeable, and on account of which it is employed as a ſeaſoner: the difference of the food of the animals has much influence upon this property of the butter. Its ſoft and very ductile conſiſtence, though in general it is concrete, varies alſo according to a great number of circumſtances. All the phyſical properties of butter are ſubject to vary according to the ſame circumſtances.

62. Very freſh butter melts at a temperature of 29 or 30 deg. Reaumur. When we keep it melted in a tube of glaſs, plunged in boiling water, there ſeparates from it, and ſwims at the ſurface, a white liquid, filled with ſmall opaque flakes, which are a mixture of ſerum of milk, and of caſeous matter. By this ſeparation, the butter becomes almoſt tranſparent; but it has then loſt its ſweet and unctuous taſte, and it has become fatty and inſipid: whence it reſults, that freſh butter owes its ſweet, agreeable taſte, to a portion of a ſerum, and of caſeous matter. Accordingly, melted butter, with whatever caution it may be prepared, becomes more greaſy, of a granulated conſiſtence, and of a

taste infinitely less agreeable than that which it had before. If the butter has been heated only to the temperature necessary for melting it, it fixes as it cools, and presents no signs of alteration. When distilled in a small retort, it affords some drops of water, rendered acrid by the sebacic acid which it contains: the greater part of the butter rises and passes over entire, with a strong pungent, and very disagreeable smell, as we see in culinary operations, where so many dishes are prepared with browned or scorched butter; much carbonated hidrogen gas is disengaged, and there remains only some traces of a dense coal, difficult to be burned, and containing scarcely any thing else than a little phosphate of lime. By re-distilling the products of the butter, we render the oil lighter and more volatile. If we distil it in a very large vessel, containing much air, we obtain more water, more sebacic acid, a less concrescible oil, more of gaseous fluid, and more coal, since the air of the apparatus contributes to the destruction of the butyraceous matter by furnishing its hidrogen with a quantity of oxigen sufficient for burning it. The sebacic acid is not contained in the butter but is formed here, as in distilled fat, at the expense of its decomposition, and of another arrangement of its principles.

63. Butter suffers from the contact of hot air, an alteration which renders it acrid and odorous. This rancidity proceeds from the

formation of ſebacic acid, which takes place with conſiderable celerity. Waſhing with water, and with alcohol, deprives the butter of a great part of thoſe diſagreeable properties.

Butter unites by fuſion with phoſphorus and with ſulphur, in the ſame manner as fat does.

The acids likewiſe act upon it in the ſame manner; the concentrated ſulphuric turns it brown, and reduces it to coal; the nitric yields to it a portion of its oxigen; the others have no action upon it.

The alkalies diſſolve it very well; ſoda forms a ſolid ſoap with butter, which might be employed with advantage in medicine. Barites, ſtrontian, and lime, harden it by combination. Ammonia, alſo, approaches it to the ſaponaceous ſtate, but leaves it liquid. The ſoaps of butter, when burned and calcined, afford alkaline, or earthy ſebates, like fat: and theſe ſebates are alſo produced by the action of the fire.

The metallic oxides unite with butter, by the aid of fire, and form with it metallic ſoaps, little or not at all ſoluble, of a plaſtic conſiſtence. In the heat it decompoſes the metallic ſolutions, and takes from them, eſpecially from the nitrates, the oxides with which it combines.

64. Amongſt vegetable ſubſtances, butter unites with the extracts; the gums, and ſugar, triturated with it, render it miſcible with water; it combines eaſily by fuſion with the reſins, the gum-reſins, and the balſams; it diſ-

ſolves eaſily in the fixed and volatile oils; it abſorbs camphor, and retains it ſtrongly; it attracts ſeveral colouring matters, with which it adheres forcibly. The laſt-mentioned property has long been employed for giving butter a more or leſs intenſe gold colour; for this purpoſe, carrots, the curcuma, the marigold, the ſeeds of aſparagus, the berries of ſolanium kalicacabum are uſed. The colours of butter may be greatly multiplied, and ſingularly varied. The root of the alkanet gives it a brilliant roſe colour, the violet a dull, but pretty intenſe blue; the leaves of ſpinnage, a brilliant green colour. The proceſſes conſiſt in mixing the colouring matters, pounded or chopped, with the cream before it is churned; the colour thus paſſes into the butter at the moment when it becomes concrete, but not before this period. Butter, coloured in this manner, keeps for a long time; it is even difficult to diſcolour it. We may alſo cauſe theſe different colours to paſs into the butter by means of fuſion; but butter, coloured in this manner, cannot ſerve for a ſeaſoning. The highly odorous matters unite with butter with facility, and we may perfume it by their mixture at the moment when it is churned, with cinnamon, cloves, nutmeg, mace, orange or lemon peel, vanilla, &c.; but very little muſt be uſed, in order to communicate to it a perfume, without acrimony.

65. It may be concluded from all that has been

been ſtated, that butter is a kind of concrete and oxigenated oily humour, reſembling fat, and not a vegetable oil, united with an acid, as was formerly believed; that this ſubſtance, without being entirely conſtituted butter in the milk, has, however, a great diſpoſition to become ſuch, and to ſeparate from this liquor in proportion as it abſorbs oxigen from the atmoſphere, when milk, and ſtill better when cream, is agitated in contact with the air; that butter, which owes its qualities as freſh butter to the mixture of a ſmall portion of ſerum, and of the lighteſt caſeous matter, and loſes them by the ſlighteſt fuſion, comports itſelf afterwards like a kind of fat, in all combinations, as well as in all the analytical proceſſes to which it is ſubjected; and that laſtly, there is reaſon to believe, according to theſe chemical phenomena, as well as from the anatomical obſervations of the celebrated Haller, that the fat which every where ſurrounds the mammary glands, contributes, by means of the ducts deſcribed by this great anatomiſt, to the formation of milk, probably by furniſhing it with the baſis of the butyraceous matter, whilſt the lymph gives it the mucoſo-ſaccharine principle; and the blood, the albumino-caſeous ſubſtance, as well as the ſalts which are diſſolved in it.

SECTION VII.

Of the different Kinds of Milk, compared with that of the Cow.

66. In the general examination of milk, and of its different parts, which has hitherto formed the object of this article, I have taken the milk of the cow as an example, as a mean term of all these kinds of animal liquors, as that which is most frequently employed, and for the greatest number of uses, because it is procured more abundantly, and more easily than any other. But it is equally useful, and even necessary for many circumstances of life, to know the characters and the nature of the other kinds of milk which are employed, either often, or only sometimes, as aliments, or as medicines, or as objects of rural manufactures, and the subjects of products advantageous to whole countries. We must therefore compare together the milkof woman, and those of the ass, the goat, the ewe, and the mare; all of which, when referred to what I have said concerning the milk of the cow, will require nothing more than the simple exposition of their differences. Most of

of the authors quoted in the beginning of this article, have ſpoken more or leſs concerning thoſe differences; but none have made them the object of more attention and ſtudy than citizens Deyeux and Parmentier. I ſhall therefore more eſpecially follow them in giving the ſpecific characters of each kind of milk, attending, like them more to the quality than the quantity of their principles; becauſe the latter, varying according to a multitude of circumſtances, preſent nothing conſtant to the obſerver.

A. *Woman's Milk.*

67. The milk of the woman is generally known to be leſs thick, leſs opaque, and more ſaccharine than that of the cow. Its coloſtrum frequently reſembles thin ſoap water; repoſe, cauſes fat and unctuous flakes to ſwim upon it, from which no butter can be extracted by agitation. The liquor, after this ſeparation, is ſcarcely opaque, becomes viſcous, ſour, putrefies, and appears to contain little caſeous matter: ſuch is the coloſtrum of the firſt day. That of the ſecond, which is whiter, affords a kind of flakey cream, which does not yield butter any more than the preceding; that of the third and of the fourth day aſſumes the character of real milk, ſtill without the poſſibility of extracting butter from its cream: the acids coagulate it well, and its ſerum is eaſily clarified.

Th

The well-formed milk, examined at different periods till the eleventh month after lying-in, prefents varieties, even at different times of the day: it, however, gradually diminifhes in quality, in general, proportionably to the length of time that has elapfed fince delivery. Its cream, which is very abundant, fometimes does not admit butter to be feparated from it; it is then very liquid, unctuous, and feems to contain an oil that is not concrefcible.

68. When the cream of woman's milk is thick, it affords by agitation firm butter, a little yellowifh, of an ordinary tafte, and in fmall quantity. All the proceffes which coagulate the milk of the cow, produce the fame effect upon that of woman; the cheefe is in general foftifh, unctuous, and does not acquire the fame concrete ftate. The clarified ferum is fcarcely coloured, its tafte is more faccharine than that of cow's milk; it contains only a little more of the mucofo-faccharine principle; Haller, however, has indicated its proportion to that of the cow, according to Navier, Hoffman, and Yonna, as 67 to 54. This ferum is lefs compounded than that of the cow, it contains lefs falts, and it is to this circumftance that citizens Deyeux and Parmentier attribute its more faccharine tafte. There is no milk that fhows itfelf more variable in its analyfis than that of woman. Upon the flighteft change in the ftate of the health, it lofes its confiftence; after

after ſpaſms it contains no more caſeous matter; it is then repugnant to the infant, who does not take the breaſt again till when the milk has returned to its natural ſtate. Thin and delicate women frequently yield ſtronger and more abundant milk than fat women. It is known with what facility the medicinal, and particularly the purgative properties, paſs from nurſes to their ſucklings; this is much more remarkable in women, than in the female animals.

69. Citizens Deyeux and Parmentier have examined even the differences which ariſe from the different methods of ſuckling the infants. According to their obſervations, great inconveniences ariſe from making them ſuck often, and letting them take only a ſmall quantity of milk at a time: it is then always too ſerous. Women, who without being aware of this, and in order to mitigate the cries of their infants, acquire the bad habit of giving them ſuck very often, and thus afford them always a too liquid or ſerous milk, in ſmall quantities at a time, are much more ſubject than others to repletions of the breaſts, and all the affections which depend upon the alteration and detention of this liquid in the mammary ducts. It appears that a phenomenon here takes place analogous to that which is obſerved in milking cows at divided periods; it has been ſeen that the firſt milk is the moſt ſerous, the leaſt thick, and the leaſt fat; and that its properties regularly

improve

improve to the laſt ſtage of milking; in this manner it is that milk-women procure creamy milk. It will therefore be attended with great advantage, both to the infant and the mother, to let the infant ſuck only at ſtated periods ſufficiently remote from each other, in order that the homogenous milk may be entirely drawn out by the ſuckling, whoſe deſire for it is then greater, and who exhauſts the breaſt more completely.

B. *Milk of the Aſs.*

70. The ſhe-aſs, when well fed and attended, affords milk always more fluid than that of the cow, the conſiſtence of which more reſembles that of the woman. It is in general not very palatable; it conſtantly affords a white ſoft butter, very liable to rancidity. Runnet, the acids, and all the well known means coagulate the aſſes' milk; its coagulum is commonly in a magma, one part of which floats upon the ſurface of the liquor, whilſt another is precipitated. The ſerum is very eaſily clarified. It has not more, or very little more colour than that of woman's milk; it is a little leſs ſaccharine than the latter, but ſenſibly more ſo than the whey of cow's milk. Haller, however, indicates for the quantity of the mucoſo-ſaccharine ſubſtance contained

contained in aſſes' milk, a greater proportion than for that of the woman. This proportion, according to him, is as 82 to 67; ſo that this liquor appears to be that which, of all, contains the moſt ſugar of milk. Citizens Deyeux and Parmentier aſſure us, that by examining comparatively the milk of three aſſes, they found many varieties in the ſerum which they obtained from it. It appeared to them to contain the ſame ſalts as that of the cow, but in ſmaller quantity.

C. *Goat's Milk.*

71. The milk of the goat is the thickeſt of all, according to the ſame chemiſts. It has a ſmell which is diſagreeable to ſome perſons, but which may be diminiſhed by attention and cleanlineſs in the feeding of the animal: that of white goats is leſs odorous than that of black ones. It affords much cream, and this yields much butter. The butter of goat's milk is white, it acquires much ſolidity, and keeps for a long time without becoming rancid. The ſame milk alſo contains much caſeous matter, which is eaſily ſeparated from it by all the well known means. It is obtained in the form of a very denſe, very thick curd. The ſerum of this milk may afterwards be well clarified; it is generally yellowiſh, with a greeniſh caſt. According

cording to Haller, the proportion of the ſugar of milk contained in it, with relation to that of cow's milk, is as 42 to 54; and according to citizens Deyeux and Parmentier, it does not contain leſs of it than the latter: but what has appeared to them very remarkable is, as they aſſert, that they found in it only muriate of lime, after having extracted from it the mucoſo-ſaccharine matter. We ſhould be led to believe that the phoſphate of lime ought alſo to be abundant in it, from the thickneſs, the hardneſs, and the length of the hair of this animal, upon the nature of which, this ſalt has much influence, as I have already indicated in the article concerning the analyſis of the hair.

D. *Ewe's Milk.*

72. Though at firſt ſight this is little different in its aſpect from the milk of the cow, it preſents, however, in the analyſis, eſpecially in that made by citizens Deyeux and Parmentier, well-marked characters which diſtinguiſh it. It affords a cream which is abundant, but has little thickneſs, from which is ſeparated a ſoft very fuſible butter, of the conſiſtence of a fixed oil, of a very pale-yellow colour, which eaſily becomes rancid. Its caſeous matter is fat and viſcid; its ſerum, which in general is difficult to be clarified, eaſily yields ſugar of milk almoſt pure

pure from the firſt cryſtallization, according to the above-mentioned chemiſts. It is, however, of all kinds of milk, that which, according to the authors collected and compared by Haller, affords the leaſt of this mucoſo-ſaccharine ſubſtance; its proportion to that of the cow is as 37 to 54. The ſerum, after the extraction of this ſubſtance, contains muriate of lime in very ſmall quantity, according to citizens Deyeux and Parmentier.

The moſt remarkable difference, or the moſt prominent character of the milk of the ewe, conſiſts in the properties or conſiſtence of its caſeous part: its viſcid and ſoft ſtate is the cauſe of the fatty conſiſtence which the cheeſes prepared with it conſtantly preſent. On this account, it is the practice in ſome countries to mix ewe's milk with the milk of the cow and the goat, in order to give to the cheeſes which are fabricated there, a more unctuous and marrow-like quality, and a ſofter paſte, which does not dry without difficulty

E. *Mare's Milk.*

73. This is the moſt fluid milk of all that have been mentioned. It has hardly any ſmell or taſte. The ſmall quantity of cream which it affords is very liquid, yellowiſh, and furniſhes only, with difficulty, a ſmall quantity of bad-conditioned butter; it ſeems that the caſeous matter,

matter, which is difficult to be feparated from this milk by the vegetable acids, remains adhering to the butter, for there remains a portion of it diffolved by thefe acids, as well as by the ferum. However, this is eafily clarified, and fugar of milk obtained from it by evaporation.

According to the extracts compared by Haller, mare's milk is the fecond in the order of the milks, with refpect to the quantity of fugar which it yields; it follows immediately after affes' milk, and ftands in the interval between this and the milk of women. The proportion of this mucofo-faccharine principle, relatively to that which cow's milk prefents, is, according to this celebrated phyfiologift, as 70 to 54. It is known, that mare's milk, kept for fome time, acquires an intoxicating quality, and it is in this milk that this property of vinous fermentation has firft been obferved.

F. *Materials of the different Milks compared with each other.*

74. By comparing, according to the details given relative to each milk in particular, the conftant nature, more ufeful to be known than the variable proportion of the products extracted from them, the following refults have been afcertained by citizens Deyeux and Parmentier by their inveftigations.

All

All the milks become covered with cream at their ſurface, but it varies in the different kinds of milk.

a. In the milk of the *cow*, it is abundant, thick and yellow.

b. In *human* milk, more liquid, white, in ſmall quantity.

c. In *goat's* milk, more abundant than in the milk of the cow, thicker, whiter, and eſpecially leſs aceſcent.

d. In *ewe's* milk, almoſt equally abundant and yellow as in that of the cow, but always diſtinguiſhable by a particular taſte.

e. In *aſſes'* milk, not thick, little abundant, frequently ſimilar to that of human milk.

f. In *mare's* milk, very fluid, ſimilar in colour and conſiſtence to good cow's milk, from which the cream has not yet ſeparated.

75. The butter, is always oily, ſweet, very fuſible, and has the following comparative properties.

a. Extracted from the cream of the *cow*, it is ſometimes very yellow, ſometimes pale, fequently white, and always conſiderably conſiſtent.

b. Difficult to be extracted from the cream of *human* milk, in ſmall quantity, inſipid, of a pale yellow colour, frequently inſeparable from the cream, which it renders unctuous; whence it has been erroneouſly inferred that this milk affords no butter.

c. The

c. The butter of *affes'* milk is always very white, foft, very fubject to fpeedy rancefcence.

d. The butter of the *goat* feparates eafily from the cream, is very abundant, always white, firm, foft, and rancefcible.

e. The butter of the *ewe*, is rather yellow, always foft, confiderably fubject to rancidity.

f. The butter of *mare's* milk is difficult to be obtained in fmall quantity, it does not affume confiftence unlefs by wafhing in cold water, and is much difpofed to rancidity.

76. The cafeous matter is alfo a conftant product, one of the conftituent materials of milk; it varies in the fpecies in the following manner.

a. That of the *cow* is voluminous, tremulous, feemingly gelatinous, very abundant, retaining much ferum which is made to flow out by a flight preffure.

b. That of *woman's* milk is little abundant, without cohefion between its particles, always unctuous and ftringy, retaining but little ferum between its particles.

c. That of the *afs*, nearly fimilar to the preceding, without unctuofity.

d. That of the *goat*, in large quantity, in a thick coagulum, more denfe than the curd of cow's milk, retaining lefs ferum.

e. That of the *ewe*, always fat, vifcid, difficult to be condenfed into curd, and giving a foft pafte to the cheefes.

That

f. That of *mare's* milk little abundant and very ſimilar to that of human milk.

77. The ſerum conſtitutes in general the moſt abundant part of the milks; it varies in the different ſpecies as follows:

a. The clarified ſerum of *cow's* milk is ſometimes of a pale yellow, ſometimes of a greeniſh colour, containing ſugar of milk and ſalts.

b. That of *woman's* milk, is little coloured, of a very ſaccharine taſte, being the third, according to Haller, with reſpect to the proportion of the mucoſo-ſaccharine ſubſtance.

c. The ſerum of *aſſe's* milk is without colour, containing leſs ſalt and more ſugar of milk than that of the cow.

d. The ſerum of *goat's* milk is ſcarcely yellowiſh, a little ſaccharine, holding the laſt place but one with reſpect to the quantity of ſaccharine matter, with few ſalts, almoſt ſolely the muriate of lime.

e. The ſerum of *ewe's* milk is almoſt always colourleſs, of a faint, and as it were greaſy taſte, the leaſt charged with ſugar of milk, containing muriate and phoſphate of lime in ſmall quantity.

f. The ſerum of *mare's* milk is little coloured, the ſecond, according to Haller, with reſpect to the quantity of ſaccharine matter contained in it; according to Deyeux and Parmentier, charged with more ſaline matters than moſt of the other milks.

SECTION VIII.

Of the Uses of Milk.

78. THE uses of milk are extremely numerous and always of great importance. They may be considered under the fourfold relation of natural uses, economical uses, medicinal uses and uses in the arts. Under the three first of these relations this alimentary and medicinal liquid constitutes the opulence of several whole nations wise in their simplicity, and happy enough in what we call their barbarism, to place their wealth in the abundance of their cattle, which furnish them with what they require for satisfying all their wants. The pastoral or erratic nations, who live almost entirely upon milk and its products, and the times in which a great number of those which are now civilized derived from it their simple nourishment, recal to our minds those happy days which the poets have depicted to us as the golden age, and it appears to the philosopher who compares those happy ages and people with those of the present day, that the mildness of this aliment of the first inhabitants of the earth, must have had an influence upon the gentleness and amenity of the manners of antiquity.

79. By swelling the mammæ of the mothers with milk immediately after parturition, nature has given to animals the two-fold advantage of a nourishment necessary to their young, and an evacuation useful to the mothers. The latter, after the abundance of the fluids which have long distended their uterine systems, find in the evacuation of the milk a discharge for those redundant fluids, whilst their young derive from it a support appropriated to their weakness, at first laxative, but afterwards becoming more and more nutritious, easy to be assimilated into their own substance, and containing, by an admirable institution of Providence, the solidifiable matter of their bones in a proportion corresponding with the rapid augmentation which these organs must experience during the first period of life. In this two-fold point of view, it is evident, that it is equally necessary to the mothers, after delivery, to evacuate this super-abundance of fluids, and to the young to nourish themselves with it: and that while the former cannot without danger renounce the suckling of their young, these likewise cannot be deprived of this aliment without inconvenience. Accordingly, severe, painful and frequently fatal diseases are the just punishment of mothers who renounce this duty, whilst a permanent weakness and languor throughout the whole of their lives, impend over the young animals that are deprived of this food.

 80. Man

80. Man muſt ſoon, and almoſt in the firſt ages of the world, have been led by obſervation to employ as food the milk of the animals which he has been able to tame and render ſubſervient to his wants. Accordingly, the different alimentary preparations of milk are traced back to the moſt remote ages of antiquity. The abundance of milk laſts only for a ſeaſon, or at leaſt it is ſoon too much diminiſhed to be ſufficient for the ſupply of the wants of man; it was therefore neceſſary that means ſhould be diſcovered for preparing it in ſuch a manner that the ſuperfluity of one period of the year might be kept to ſupply the deficiency of the others. Hence the different kinds of cheeſes. The natural alterations which milk undergoes, being early obſerved, have alſo given riſe to the great multitude of various aliments that are prepared with this liquid, eſpecially cream, butter, curd, butter milk, ſour whey, &c. The Tartars have long poſſeſſed the art of preparing intoxicating liquors with milk. Its employment as a ſeaſoner, its mixture and combination with fruits, honey, ſugar, the different infuſions and decoctions, the vegetable perfumes which add more or leſs agreeable taſtes and ſmells to the mildneſs and unctuoſity of milk, were not contrived till long after the diſcovery of the products obtained from this liquid. Art has ſo much multiplied this preparation, that it would be uſeleſs to attempt their enumeration;

meration; besides which they vary in the different countries. Modern chemistry has added to the ancient economical uses of milk, that of converting it into vinegar, which in certain provinces may be an advantageous substitute for the acid furnished by wine, cyder, beer and the four fruits.

81. There are few medicinal substances that have been applied to such a multitude of uses by the physicians as milk. As a mild, relaxing, emollient, cooling substance, it is adapted to a great number of maladies. There are some even upon which it seems to exert a specific action, as the attacks of the gout, the rheumatism, obstinate herpetic erruptions, incipent depravation of the lungs, ulcerated affections of the urinary passages, &c. To this general and common action of all kinds of milk upon the animal economy, experience has shown that we may add the particular action of each species of milk: that the milk of the ass is the lightest and the most easily digested; that of the goat much heavier and adapted for strong and vigorous stomachs, and for those cases in which the body is to be nourished and invigorated; that the human milk, the sweetest and most saccharine, in which the caseous part is the most abundant, is on the contrary well adapted to weak stomachs and difficulty of digestion. Accordingly, it is with the intention of fulfiling these different indications that the physicians prescribe one or the other of the four kind

kinds of milk, the human milk, goats' milk, asses' milk and cows' milk. They have also thought fit to divide the milk and to dilute it with water, to prepare from it the whey or serum, and to administer it either sweet and clairified, or soured, to combine the different kinds of milk with different remedies, to soften or moderate their effects by this addition, or to favour the intromission of this liquid into the humours by giving it a little more activity, by correcting its insipidity, its weight upon the stomach, its occasional astringent effect, or on the contrary its relaxing operation. It is necessary that the physician should be provided with an accurate knowledge of chemistry, in order to be able to prescribe these mixtures and these combinations of milk with different medicinal substances without destroying the properties of the latter: thus he ought to know that lime water precipitates calcareous phosphate from it by passing itself into this state, that many metallic salts are decomposed in it, and that matters susceptible of acescence coagulate it. Lastly, the administration of milk in medicine has been carried so far, as to impregnate it with some medicinal properties by treating in different ways the animals that furnish it, or the nurse herself who suckles the infant.

82. The multiplied resources which the milk of animals affords under a thousand diversified forms, leave but little room for the use

ufe of thefe valuable liquids to arts not belonging to the nourifhment of the body. However, though it be not much employed in the arts, it is however not without utility in this point of view. Milk that has become four and turbid is frequently employed in the manufactories where fine cloths are dreffed, in order to give them that beautiful white which is not improperly called milk-white. It is even believed in thefe manufactories that no other fubftance can be fubftituted for this lactic acid, though able chemifts have maintained that the fulphuric acid diluted with water produces the fame effect. Barrels filled with four whey are fent from the rich mountains of Switzerland into France, for the purpofe of being employed in this procefs of bleaching. I have elfewhere obferved, that the cafeous matter, kneaded frefh with lime, forms a tenacious pafte, fufceptible of hardening, which is employed for cementing broken porcelain together. Rancid butter is rendered fubfervient to a number of ufes by the induftry of the chemical arts: it is manufactured into foap, and other compounds.

END OF THE NINTH VOLUME.

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